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AMERICAN FARMING

AGRICULTURE IV

BY

ANDREW BOSS, D.Sc.
Emeritus Professor of Agriculture and Farm Management,
University of Minnesota

HAROLD K. WILSON, Ph.D.
Professor of Agronomy,
University of Minnesota

AND

WILLIAM E. PETERSEN, Ph.D.
Professor of Dairy Husbandry,
University of Minnesota

GENERAL EDITOR, A. M. FIELD, Ph.D.
Professor of Agricultural Education,
University of Minnesota

Saint Paul *Minnesota*

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PREFACE

Agriculture, as a subject for study in the high school, is a relatively new addition to the secondary school offerings. In early years there was a tendency to use the few available textbooks as the basis for developing the course of study. As the teachers gained experience the selection of subject matter and the emphasis on correlation of activities shifted to the natural needs of the students as the important basis for determining what to teach and how and when to teach it. The needs of the farm and the farm practice program of the students became the important factors in the selection of the content for the course of study. The activities of the students shifted from the study of agriculture as a subject to the study of farming as a business. The farm-as-a-whole approach to the study of agriculture came into prominence. With it also came the problems of selecting and organizing appropriate learning materials for each year of study. Students and teachers were in need of guidance as to where to begin and in what directions to go. It is with the hope of meeting the situation and directing the study that the AMERICAN FARMING series has been prepared.

AMERICAN FARMING: *Agriculture IV* completes the four-volume series of books organized to furnish basic material as a source of information and to make practical the study of agriculture in the secondary schools. The books are designed to serve as guides to teachers and to students in pursuing a course of study that is organized on the cross-section basis. In AMERICAN FARMING: *Agriculture I* the students gained a broad, field-as-a-whole view of the problems of farming and the place of agriculture in American life. Subject matter, practical experiences, and guidance activities were geared to the interests, needs, abilities, and opportunities of first-year students in the high school. In AMERICAN FARMING: *Agriculture II* and *Agriculture III* the emphasis shifted to experiences dealing more specifically with problems of organization and operation as applied to the home farms of the students. With the experiences and study of the previous years as a background, AMERICAN FARMING: *Agriculture IV* directs the student to a functional understanding of the inter-relationships of the more technical and complex problems of the science and art, the business and social aspects, and the economic principles of successful modern farming activities. It enables the student to use the information he has gathered through the past three years, in order that he may carry it into actual practice. Essentially, *Agriculture IV* presents additional phases of subject matter and practices not previously given, so as to fit the students more fully for the actual business of farming. Now that he has learned the principles, it is important that he know how to put them into operation. Emphasis is focused on desirable plans and programs that will lead to satisfactory establishment in farming.

The senior year in high school is for many students the last year in school. If the program of their education has accomplished its purpose, the students have made a choice of the vocation they plan to enter. The students who have decided to enter farming as a life work have learned much that will be helpful to them. They have learned to think in terms of problem situations. In their practical activities they have learned how to work, and, in many cases, they have acquired some capital and property to help them get started as farmers. As farmers, these young people are not only going to work to make a living but they are also going to live a life. They must be prepared to fit into the social pattern of the community in which they live.

In selecting the course of study materials for *Agriculture IV*, teachers should include experiences drawn from the social and cultural patterns of the local community. Integrated with the subject matter in *Agriculture IV* might well be training and experiences in such citizenship areas as rural education, rural organizations, civic opportunities and responsibilities, church work, health and recreation, personality development, marriage and family life, and economic citizenship. It is impractical to attempt to include in this book all appropriate materials bearing on these vital problems. There is an abundance of available literature that teachers can obtain. Much of the material can be drawn from the local community. There are many important local persons who can be persuaded to present views and problems for further discussion by the students.

The authors wish to express their appreciation to co-workers who have made many valuable suggestions in connection with the preparation of the material presented. Particular appreciation is expressed to Dr. H. K. Hayes and Dr. C. R. Burnham, of the Division of Agronomy and Plant Genetics, Minnesota Agricultural Experiment Station, for their help in connection with the preparation of material dealing with plants. Dr. W. Ralph Singleton, Connecticut Agricultural Experiment Station, furnished a number of photographs and gave suggestions on the material dealing with breeding. For assistance in preparing Chapters I, III, IV, V, and VI appreciation is expressed to R. E. Hodgson, Superintendent, Southeast Experiment Station, Waseca; E. J. Falvey, formerly Legal Specialist, Agricultural Extension Service, University of Minnesota; W. L. Cavert, Director of Statistical Research, Farm Credit Administration, St. Paul; D. C. Dvoracek, Specialist in Marketing Economics, Agricultural Extension Service, University of Minnesota; and L. J. Nelson, Assistant to the President, Federal Land Bank, St. Paul.

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CHAPTER I

DO I WANT TO FARM?

Some persons never have to ask this question or weigh the advantages against the disadvantages of farm life. They are born with an urge to live out of doors with growing things, and no other occupation would satisfy them. In other cases, young persons grow up on the farm and never dream of things to do beyond its boundaries. They stay on the farm from inertia. "Father was a farmer; so, too, am I."

Not many years ago, the impression was common that a boy, too dull for anything else, should farm. The smart lads were sent to the cities for professional work or business, while the slow-thinking boys, with less polish and personality, were supposed to remain at home as farm drudges. Now that picture is changed. It takes a smart man to operate a modern farm successfully. The boys with less "spring" in their heels and heads may be more successful in putting on "nut number 17" in a factory assembly line.

If one is seriously looking for an answer to the question, "Do I want to farm?" it may be wise to check this interest with a series of personal likes and dislikes, advantages and disadvantages which may help one to arrive at the correct decision. Do I like to work with my hands as well as with my head? Do I like farm animals and enjoy working with them? Do I prefer to work outdoors or in an office or factory? Can I use and repair machinery? Can I see things which need doing and work out a plan for doing them? Can I get the most satisfaction from "bossing myself" rigorously or would it be more comfortable to let someone else take the responsibility of telling me what to do? Am I more interested in getting a job well done or in working by the clock? The answers to these questions will go a long way in determining what one should do.

FARM LIFE HAS MANY ADVANTAGES

Farming appeals to some persons but is like poison ivy to others. There are farm operators who have made a living from the land, though it was always an unpleasant occupation to them. Perhaps they inherited a farm and did not know what else to do with it. Whatever the reason, it would be difficult to find success as measured in personal satisfaction and happiness unless most of these questions can be answered favorably. For those who have had limited opportunity to become acquainted with agricultural operations, it may be helpful to outline some of the advantages and disadvantages of farm life.

Farming, a Nature Lover's Job. Most persons inherit a persistent love of nature. Those who live in the city enjoy feeding the birds in the park, growing flowers in window boxes or arranging unusual effects through landscaping. Even in crowded tenements this urge to make something grow is not unknown, though its only outlet may be a few geraniums in tin cans. The farm offers full opportunity to satisfy this natural instinct. Nature is an intricate, fascinating, and mysterious mechanism which constantly rearranges chemical elements by breaking down, through decay, old forms which are no longer useful and building new plants or animals in endless succession. It is the farmer's function to understand and take advantage of these processes in such fashion that human needs may be met for food, clothing, and shelter. Finding ways of satisfying our wants from nature's resources is an age-old task, but always new.

For one who loves this work there is constantly recurring interest and pleasure in ordinary farm operations. Starting for the field in the morning, when the air is sweet, the grass shining with dew, the bird chorus at full volume, is an experience one never forgets. It is good to feel strength in healthy muscles, able and ready for the day's task. It is intensely satisfying to drive a powerful, well-matched team or a tireless tractor responsive to a touch of the finger, while preparing the fertile soil just longing for the seed, or to harvest a fat crop, the reward of nature's abundance and man's well-directed effort.

There is sentiment, comedy, pathos, and tragedy in associating with livestock. There is the miracle and suffering of birth with the wholesome excitement of helping a new arrival to its feet and gently introducing it to the "fountain of youth" proudly offered by its anxious mother. There is the comradeship of trusting animals whose well-being is dependent upon the skill, labor, and sympathy of their caretaker. There is the welcome when the barn door is opened each morning and every friendly animal calls a greeting. There is stimulation in watching hungry animals convert quantities of rich feed into meat, milk, or power. And there is a heartening financial reward in sight when the job is well done. Farm life offers many attractions.

Figure 1. Even in these days of automobiles and tractors, a good colt holds strong appeal to most farm boys.

Farming Healthful. Farming is a healthful occupation. Modern farm homes can have every city convenience. Hard work in the open air enables one to enjoy an abundance of good food, largely home grown, and an easy chair when the labor of the day is ended. It is an ideal place for children, because they have ample room for play and daily duties which teach thrift, order, and responsibility as companions and partners with their parents.

The home is the business office of the farm. Here plans are made for organizing the daily operations, so that the home may prosper. Every member of the family can be a director in the firm, with a definite part in making the income adequate for the attainment of individual needs and family ambitions. Children learn the rewards of hard work. The facts of life are commonplace and well understood. Companionship with animals is clean, wholesome, and instructive.

The farm family is a unit representing management, labor, and capital. Every member has a job worth doing, with the returns limited only by ability, application, and the chances of nature. Those who are capable of enjoying hard work, close family life, and intimate association with living, growing things in God's great out of doors, will be able to find much satisfaction in life on the farm as mutual interests develop.

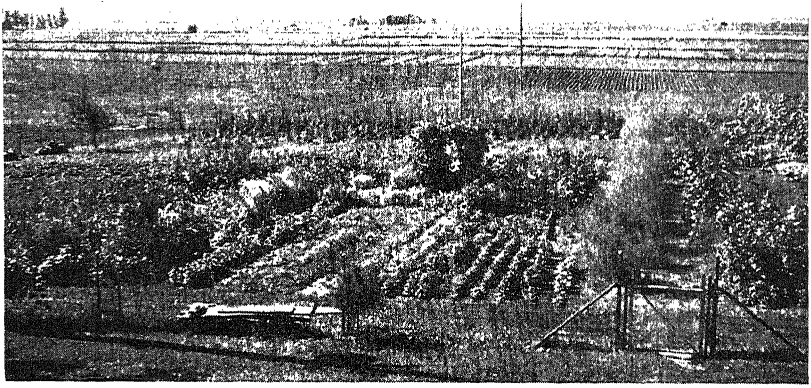

Figure 2. A farm garden well filled with fruit, vegetables, and flowers adds much to the attractiveness of a farm home.

FARM LIFE HAS RESPONSIBILITIES

Every profession, occupation, or way of life has an appeal which makes it attractive and also disadvantages which are inevitable. In choosing a path to follow, young men or young women will do well to weigh carefully their personal likes and dislikes in order to select a field of work which will bring the maximum satisfaction of their individual tastes, wants, and desires. The only way any profession can become a "bed of roses" is to find so much enthusiasm and inspiration in the pleasant and enjoyable things that the unpleasant parts shall become relatively insignificant.

Farming has features which make it pure drudgery for some persons. Take, for example, hard physical work, of which there is never a lack where livestock and crops are being grown. Mental labor is needed for planning, estimating, and in developing sagacity and judgment in the conduct of a business. A young man may prefer headwork or handwork, but a farmer must do both. Boys like to play football and glory in their bumps, their strength, their strategy, and their success. Life can be a game or a prison sentence, depending on one's attitude and reactions.

The growing of crops and livestock requires hard work, both physical and mental. With the animals especially, it necessitates constant care and attention. Cows have to be milked and hogs fed, even when the circus comes to town or the local Farm Bureau is holding a picnic. On a one-man farm the operator is literally tied to his milk stool—or milking machine in this modern age—and he must care for his stock at least twice a day regardless of allurements elsewhere. Of course, he will soon plan to enlarge his operations, so that two workers shall be available, to change about when time off is needed; but the farm manager is never free from responsibility for all the animals, equipment, and operations under his direction.

Farm Duties Variable. The farmer must be somewhat of an engineer in laying out his farm buildings, arranging his fields, deciding what machinery is necessary, and balancing his program, so as to bring about the best results. He must do the work of a mechanic in repairing machinery, maintaining plumbing and electric lines, overhauling tractors, mending harness, or patching and remodeling buildings. It takes too much time and money to hire all these things done.

The farmer must be an agronomist to make the best use of his land, decide what crops to grow and where to grow them, keep informed on new varieties that are being produced and the latest methods of combatting weeds, insects, and diseases which will keep his useful plants from attaining full production.

A good livestock man must understand the principles of animal breeding and the manner in which characters are inherited. He must be able to judge animals as to their good qualities and defects. He must nurse them when sick, understand vitamins and diets, know the composition of feeds and their effect in various combinations, recognize common diseases and symptoms, learn how to avoid or treat contagious diseases, so as to keep his stock healthy and contented.

The farm manager is responsible for every weed, every plant, every machine, every animal, every post, and every piece of wire on the farm. Each one of these can make trouble or contribute to the well-being of the whole enterprise. A farm that is well run works smoothly most of the time and "good luck" prevails; but, let the farm manager neglect his job, even for a little while, let him "put off" something he doesn't like to do, let him get so mired in details that he fails to see all parts of the picture, and the farm will run him. It will run him ragged.

The Farmer a Business Man. Engineer, mechanic, agronomist, animal husbandman, the farmer is also the business manager of his enterprise. He can lose his profits by poor trading or lose his farm by unwise financing. He needs to know something of business, legal procedures which relate to the farm, economics, bookkeeping, and enough banking to use credit without abusing it. It is obvious that all our present farmers have not had special training in these phases of the whole farm problem, but the successful men have learned something about them, often through hard and costly experience.

Lessons may be learned by training or trying. Difficulties, troubles, mistakes, and losses may be avoided by learning from others; so the more complete the information possessed by the farm manager, the more smoothly his work is likely to progress. There will always be plenty of projects to try, plenty of new experiences, and plenty of things will go wrong, but sound training will help to solve problems as they arise. Headwork will often replace considerable handwork, especially as the enterprise grows and the operator gets older, wiser, and more competent.

Besides his care for every part of the farm organization and operation, the farmer is responsible for the habits, character, and welfare of those depending on him. It is his duty to see that labor and recreation are so distributed that both serve their best purposes. He is obligated to provide the best housing and the most comfortable and healthful surroundings for his family which his ingenuity and financial condition will permit. Money and labor are both necessary on the farm; but, if they prevent the development of a pleasant and happy family life, the organization becomes unbalanced and can not achieve the greatest success as measured in human values.

A good farmer must also assume responsibility toward his neighbors, his community, his state, and his country. Certainly, a part of his skill, knowledge, and effort should be used for public improvement. He must then take an active interest in school, church, co-operative enterprises, township affairs, and politics in the broadest sense of the word. American institutions do not run themselves. They depend on the understanding and the directed effort of individual citizens, continuously applied to local as well as state and national conditions. A good farmer is a helpful member of the community. What is good for all is good for him, and unity of action brings achievement.

Figure 3. Wealth and satisfaction accumulate rapidly from a good foundation herd.

FARMING OFFERS OPPORTUNITIES

The young man who asks "Do I want to farm?" naturally thinks first of the immediate advantages and disadvantages of farming as a steady, day-to-day job. Next, he will want to look further ahead. "Where shall I be twenty years from now?" There will follow another series of questions which may apply to any profession, and, again, personal ideals, ambitions, talents, and preferences must be considered in the answers. "What is the goal of achievement?" If it is to make much money quickly, farming is not likely to be the life which he should seek. That aim is more likely to lead to large cities and big business. If his hope is for security, peace, contentment, a pleasant home, and reasonable independence, a farm offers plenty of opportunity, if he is capable and willing to earn advancement by his own efforts. Few paupers are found on farms.

The only way to accumulate property is by saving. Men on a salary know exactly what their income will be and usually set their standard of living accordingly. They have little incentive for saving, because there is no immediate place to put aside money except in a bank or in life insurance. It takes imagination to see more value in cold black figures in a little book than in a hundred comforts or pleasures which may be enjoyed immediately.

On the farm it is only natural to accumulate property. At the end of the year there are likely to be more calves, lambs, or pigs than at the beginning. Fences, tile lines, machinery, tools, buildings, water systems, electric service are all wants which may be satisfied by relatively small accumulations of money, but together they add up as increased property. In other words, there is a strong incentive for farmers to buy or keep things of permanent or semipermanent value. At the end of twenty years, if reasonably efficient in financing and fairly successful in his operations, a farmer is much more likely to have a comfortable estate than a man of equal ability who lives in the city.

Few farmers become wealthy as measured by city standards, but the proportion of farmers who earn a comfortable living is undoubtedly higher than the average in the city. Unusual ability can earn an unusual income on the farm, as elsewhere. An annual labor income of $3,000 to $5,000 per year is not uncommon among farmers, particularly those who have developed some specialty. A great many farmers accumulate estates of $50,000 and up. Aptitude, training, ability, and energy are important factors in earning satisfactory farm incomes.

Part of the farmer's pay is in satisfaction. It is a personal business, in that the manager plans and executes the whole range of production from calf to fat steer, from seeding to harvest, from hay to butterfat. It is sometimes disagreeable to get up in the middle of the night and wade out through snow, mud, and slush to see that a farrowing sow is progressing favorably and saving her pigs, or to help a cow welcome her offspring; but the disagreeableness disappears, however, as one lifts a gangling baby calf to its feet and assists it to find the usual source of warm milk, and visions a high-producing cow, a valuable bull, a prize winner at the fair, or part of a new car purchased with the income this arrival will bring when well raised.

There are few business enterprises which permit an individual to exercise such complete control over all the factors of production as one does in farming. The quality of product is largely due to his own skill and effort. A fine bunch of hogs, a yard of fat cattle, a high-producing herd of cows bring satisfaction and contentment with a task well done. There is always a goal toward which to strive, something new to try, freedom of action, responsibility of the highest order, and, as a reward, a comfortable home, an adequate income, substantial savings, and as much independence as anyone can have except on a desert island. There is much satisfaction in successful farming.

All these inducements help to insure stability. The farmer settles down to a life job, usually on one piece of land. He hopes to manage that land in such a way that it will remain rich and productive. He plans to put up a fine set of buildings as he earns the money for them. This is his home, his life work, most of his recreation, and his estate. As he advances in age, his property should increase, his debts should be paid, his sons or younger men should take over the harder physical labor, leaving the manager more free for community work, travel, and outside activity, yet retaining control because of his experience, skill, and managerial ability.

DOES THE FARM WANT ME?

Before a business man hires a new employee, he tries to determine whether the worker is capable of filling the position and rendering services worth more than his salary. Since on the farm the manager represents both capital and labor or is both boss and hired man, it is well for him to make the same sort of inquiries. What are my ambitions? What can I do? How well can I do it? Am I willing to be for myself the toughest boss I ever had? Did my lessons sink in, or do I blame failures on "hard luck" or "the other fellow"?

If it is one's ambition to be a bank president, the farm is not the usual starting point. Try to examine your own likes and wishes, then put yourself in the place of an experienced operator and, from his viewpoint, decide whether this young man (you) has the stuff it takes to become a farmer. Is he self-reliant? Is he trustworthy? Can he see what needs to be done or does he have to be told? Can he take hard work, hard knocks, hard experiences and come back for more? Can he plan? Does he love nature and the out of doors? If so, he may be worth a trial.

Too many men who live on farms are not prepared to make a success of their vocation. Some are able to overcome a lack of schooling by self-training and learning by experience, but this way is hard and expensive. Boys who have a chance to attend school can gather the accumulated wisdom of millions of farmers over hundreds of years just by reading books. Botany and zoology cover the nature of plants and animals. Chemistry explains the properties of matter. There is, therefore, a chemistry of nutrition which treats of the substances which are involved in the fertilization of soils and the growing and productivity of animals. Mathematics underlies computation, engineering of land, measurements, operation of machinery, and construction of buildings. Physics is applicable in the use of pulleys and levers. A branch of physics is meteorology, which explains the phenomena of all phases of the weather. All these studies form a sound background for a better understanding and successful solution of many farm problems, when wrong answers might mean serious mistakes and considerable loss.

Figure 4. A small flock of sheep offers opportunity for a good partnership project that keeps interest centered in the farm.

But books alone will never make a farmer. He must also learn by doing. Books can not describe how much work a horse can stand today, but a farmer must know. Too little work does not get the mowing done. Too much kills the horse. Skillful drivers can accomplish a great deal of work and bring in their horses feeling fine. Others fret their teams, do far less work, and are likely to injure their stock. Similar examples might be cited for all livestock, crops, and management. "Book learning" is an excellent foundation on which to build experience well based on facts. If experience is supported only by hearsay, rumor, or imagination, it is not always reliable.

And, lastly, if it has been decided that I want to farm and the farm wants me, what are my resources? Land, stock, and machinery represent capital, all the way from $5,000 up to $60,000 for average-sized farms. There are, of course, occasions when young men receive a farm by inheritance, but the large majority have to start with their own bare hands and little else. The way up involves a long climb and a stiff task, but is being traversed successfully in all parts of the country. An able head, skilled and willing hands, good health, a strong back, and plenty of determination will bring an affirmative answer to the question, "Do I want to farm?"

Suggestive Questions

1. Do I like to work with my hands as well as with my head?
2. Do I like farm animals and enjoy working with them?
3. Do I prefer to work out-doors or in an office or factory?
4. Can I use machinery efficiently and repair it when repairs are needed?
5. Can I see things which need doing and work out a plan for getting them done?
6. Do I want to be my own "boss" or have someone else tell me what to do?
7. Am I interested in "getting the job done" or in "working by the clock"?

Suggestive Activities

1. Make a list of all the usual farm tasks that you best enjoy doing.
2. Make another list of those you very much dislike to do.
3. Compare these lists with those made by other members of your class and discuss ways in which the unpleasant tasks can be made more pleasant.

CHAPTER II

BECOMING ESTABLISHED IN FARMING

To become well established in a good farm business requires much thought, objective planning, and careful and well-timed investments. Only those possessing considerable free capital can buy outright a well-organized, fully-equipped farm, ready for immediate operation. Most young men who wish to enter the vocation of farming will have to begin, in a modest way, to build themselves into the ownership of a farm, wherever they can find what appears to be an attractive opportunity. This effort may extend over a period of years. The accumulation of property or additional capital year by year, however, is a stimulating experience and will lead eventually, if pursued, to the desired objective. Experience has shown that the farmers most likely to succeed are those who begin in a small way, learn by practice, and slowly accumulate property by their own effort and management. In this way costly mistakes may be avoided.

There are various ways in which young men can start toward farm ownership. The following are suggestive:

1. Many start by undertaking a project on the home farm, working in co-operation with their parents. Savings accumulated may become the source of later property ownership.
2. Others may work out a partnership agreement in which they, with their parents, operate the home farm on some specific plan under which the income is divided equitably in proportion to the contribution made by each toward its operation.
3. Still others may undertake to rent the home or other farm fully equipped, where only the man labor and management are furnished by the operator.
4. Those having nothing with which to start and unable to work into one of the plans suggested may have to start as farm hands and from their earnings save funds with which to buy sufficient power and equipment to operate a farm on a rental contract, and eventually buy as capital is accumulated.

5. There is also in some cases the possibility of acquiring a farm by inheritance or by partial inheritance. In instances where there is only one child in the family this method is a natural and logical step. Where there are two, three, or more children, it may involve the problem of buying out other heirs, in which case unsatisfactory family relationships may arise. That a better understanding of the possibilities under these plans may be given, a more complete discussion of each plan follows.

A HOME PROJECT PARTNERSHIP

On many, but not all, farms it is often possible to set up a crop or livestock project for which one or more of the children of the family take the financial and management responsibility. Many examples of such projects are found in the records of 4-H Club members, Future Farmers of America, and others engaged in organized agricultural activities. Under such arrangement the junior member usually acquires through gift or purchase, sometimes on borrowed money, the ownership of one or more animals, a flock of turkeys, chickens, or other poultry. By specific agreement he is allowed building and yard space as needed, and either land for producing needed feeds or the privilege of feeding from farm-grown supplies. If feeds or supplies

Figure 5. A father and son talk over the hybrid corn project which has been agreed upon as the son's responsibility and source of income. Division of Publications, Department of Agriculture, U. of Minn.

that are not produced on the farm are needed, the project operator should be enabled to make necessary purchases to be paid for out of earnings. In cases where the nature of the farm business does not lend itself to livestock production, a project may be set up covering some crop or product lying within the usual farm activities. A few acres for the production of a good market crop, a good-sized plot of potatoes, popcorn, or beans is suggested as suitable bases for project work on many farms.

The objective of such projects is to develop initiative, resourcefulness, and good judgment on the part of the young operator. There should be, at the same time, a fair prospect for financial gain under good management. In all cases the operator should keep a complete record of all expense and income, and show the profit or loss from the undertaking. Needless to say, the proceeds from operation should go to the project worker as a start toward property ownership.

TAKING MANAGEMENT RESPONSIBILITY

Another form of activity which does not involve ownership contemplates taking over the care and management of some specified crop or a group of animals. As a reward for participation in the work of the whole farm and for the labor and management expended on the special enterprise, the project operator receives a reasonable percentage of the sales income from it. An illustration of this type of project will show the possibility for earnings from such a source.

On a farm where 20 brood sows were normally kept, a late "teen age" son was offered a 20% share in the sales from the hogs if he would take over their care and management. In addition, he was to assist with all other farm work as time and strength permitted. The normal marketings from this farm annually were 110-225-pound hogs, a total of 24,750 pounds. At 6c per pound the income from the hogs would be $1,485.00. Twenty per cent of this amount is $297.00. This sum was practically the equivalent of $25.00 a month for the year in addition to room and board, which is more than was being paid for hired hands at the time.

One must keep in mind the fact that the income of the owner of the farm was reduced by this amount. The reduction is only a little more, however, than would have been required to pay a hired hand outside the family. The son was at the same time developing initiative and learning to take responsibility, both which abilities are valuable assets for later operations. One should understand also that, where there are several children in the family, the average farm could not afford projects for each with such generous participation in the farm income.

There are too many variations in the types of project that may be undertaken to permit full description here. Each farm and each farm family offers its own problems and solutions. It is not uncommon to find a son receiving 10% or 15% of the total farm income in lieu of total income from a definite project as a reward for his year of service. Cases are on record where a 15% share of the income from a 160-acre farm added $475.00 to the net worth of one youth and $338.00 to the net worth of another. Still another who received 15% of the gross income, but who paid 15% of the expense for mill feed and hired labor, gained in the year $463.00. In some cases the project operator may receive a specified proportion of the income from the dairy herd or from beef and hog sales. In other cases he may get the income from a specified number of sows and litters or from specified cows in the dairy herd. In some instances a limited tract of land is rented as a project and operated with power and implements furnished from the home farm. Generally, such land is used for the production of a special high-income crop. Where the acreage is large it may be used for the production of any of the normally-grown cash crops. The income from such projects goes to the project operator, who should, in case of an adverse year, stand any loss that may be met from low income, thus learning to meet hardship as well as good fortune.

Since the object in view is the accumulation of capital for further ventures toward the ownership of a farm, the operator should be encouraged to use his earnings in renewed productive enterprises as opportunities arise. Sharing in the responsibilities of the farm business develops initiative and gives valuable training. It also helps to establish self-confidence and good judgment. The record keeping and annual check-up on financial gains will also lead to thrift and the habit of objective saving, thus progressing toward eventual farm ownership.

It is impossible to outline all the forms which these project enterprises may take. Enough have been suggested to illustrate the idea. Fortunately the Extension Services of the Agricultural Colleges in most states have been active in developing this type of work among young people and can give assistance, if wanted. Club and Chapter leaders, instructors in Vocational Agriculture, and County Agricultural Agents also are in position to give aid in developing programs for project work.

FARM PARTNERSHIP BASIS

In some instances where a son, or, in exceptional cases, a daughter, wishes to join in the operation of a farm, it may be advisable to work out a partnership agreement covering all operating activities. The form of such agreement will vary from case to case in accordance with the type of farming and the contributions that can be made by each party to it. In general, the father and the son will each contribute his labor and management to the partnership to the full extent of his ability. Each party should receive a reasonable monthly or yearly wage allowance, or "drawing account," in proportion to the labor and management contributed and within the anticipated financial returns from the farm for the year.

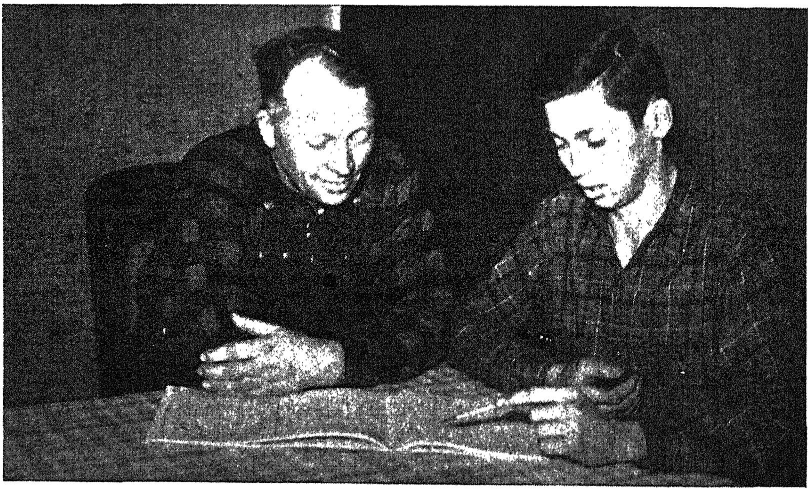

Figure 6. Everything is on a business basis in the partnership arrangement in the Olson family. Complete records are kept of every transaction along with production records. Division of Publications, Department of Agriculture, U. of Minn.

Records Must Be Kept. Such partnership should be based on full and complete records of all farm transactions. It should begin with an appraisal of the value of the farm as a unit, recording separately the estimated values of land, building, wells, fences, and all other improvements that may be regarded as real estate. An inventory, showing ownership, amounts and estimated values of livestock, machinery, power implements, tools, feed, growing crops or grain, and supplies of all kinds will complete the opening records. Records of cash receipts and expense must be kept. These records, with the annual inventory, will serve as the basis for an annual settlement and show the returns from operation and the proportion going to each party.

If the farm is not completely developed and buildings, fences, wells, drains, or other improvements are made on land owned by the father, the necessary money and labor are to be furnished by him. Should the son contribute labor or funds to such improvements, he would be entitled to receive pay for his contribution, when performed or when the partnership is closed, as may be mutually agreed.

Ownership Problems. Ordinarily, a son entering into such a partnership would own little or no personal property. This problem can best be met by the son's buying a one-half interest in that owned by the father. For the half interest taken over at inventory prices the son would give a note secured by the property purchased. This note would be retired by payments made as stock, crops, or other products in which he shares are sold or from his share of the income, when the annual settlement is made. Eventually he becomes a property owner.

Joint Account Advisable. In operating the farm under a partnership agreement, it will be best to put all cash receipts into a joint account open to both parties. Into such joint account would be entered all receipts from the sale of livestock owned in common, from livestock products, crops, and any other source covered in the agreement. The cash expense for feed, seed, hired labor, rent, taxes, new machinery, power, machinery repairs, telephone, electricity, and miscellaneous supplies should likewise be paid as operating expense out of the joint account. To one party or the other should be entrusted the task of keeping the records with mutual understanding as to the form and an agreement of the firm name in whose account the business will be transacted. If a checking account is maintained with a bank, agreement should be reached as to signatures and withdrawals. The checks may be signed by either party, by both, or by a firm name such as "John Doe & Son," when mutually agreed to and arranged with the banking house.

The net returns from operations may be determined at the end of the year by the amount left in the joint account after paying all cash expenses, including the monthly allowance for each partner and plus normal increases or minus decreases in the inventory of personal property.

Annual Settlement Desirable. In making an annual settlement, which is always advisable, there are two other items that should be taken into account:

1. As a full partner in the enterprise the son is entitled to living quarters and to one half of the food and fuel produced on the farm. He should, on the other hand, pay one half of the cost for purchased food and fuel. Ordinarily, this would be covered in the joint account from month to month; but, if not, it should be considered and adjustments made at the close of the year. The record should show adjustments required.
2. One party or the other may acquire a larger capital investment than the other. In that case, the one having the larger investment should be allowed interest, at a rate mutually agreed, upon his excess capital before the equal division of net returns is made for the year's operations.

Should it become advisable to close the partnership, an appraisal of all property owned in common should be made jointly. Settlement can then be made on the basis of the ownership share of each. If equal division of the property is not practicable or advisable, one party may agree to sell to the other at the appraised values. A provision for an arbitration committee, in case of disagreement, should be made in drawing up the partnership contract. A form of such contract in use in Michigan is offered at the close of this chapter. Other states may have similar forms which can be used as a pattern, although each partnership agreement is likely to vary in the details of the contract made.

It is always advisable to put in writing the terms agreed upon for any such partnership contract. Verbal agreements, while valid if witnessed, are much more likely to be misunderstood than written ones. In writing the agreement all important items should be freely discussed until fully understood by both parties. Estimates of costs and returns to each party will help in gaining knowledge of probable equities. Agreement as to management and responsibilities should be included. Provision may be made for readjustments in the agreement if it is found, after a year or two of trial, that the original form results in unfair equity to one or the other party to it.

CLIMBING THE AGRICULTURAL LADDER

Many young men find it impossible to develop home project enterprises that result in satisfactory income or to work into a fair partnership contract on the home farm. For them there is left the old process known as "Climbing the Agricultural Ladder." To do so is to work as a farm hand until sufficient capital has been accumulated to purchase power and equipment for operating a rented farm, and then to operate as a renter until sufficient capital is accumulated to make a substantial down payment on a purchased farm which is the final objective. While this process is slow, it has certain advantages that will bear further discussion and consideration.

Starting As a Farm Hand. One starting at the bottom of the ladder as a farm hand should keep the final objective in mind, else he may become discouraged at seemingly slow progress. Wages for farm hands are usually on a low scale. Working and living conditions are not good on all farms and frequently the work days are long. Before employment is sought a young man should observe carefully the farms, the equipment provided, the type of farming, and the management practices of possible employers. He should also give consideration to the reputation of each in regard to integrity and fair dealing. The period of employment should be looked upon as an apprenticeship as well as a job. One can learn much about farming and farm management by working under the direction of a good farmer. Good wages are a first consideration, but of equal importance are good living conditions and the educational influence of a good farmer. There is no other way in which farm experience can be gained at so little cost as by working for a first-class farmer.

To gain the farm ownership objective, wage saving must be firmly established as a habit. Living expenses in rural communities are low, as a rule, and a good share of the cash wage can be saved by a thrifty worker. On a cash wage of $40.00 a month it should easily be possible to save $300.00 to $350.00 a year. At that rate enough capital can be accumulated in the course of five to seven or eight years to buy a modest quantity of stock and equipment for the operation of a rented farm. Such a program does not allow for the purchase of a "jallopy" and frequent trips to neighboring towns, movies, and other money-catching devices. Rigid economy and self-denial are the price for financial progress. The savings made can be increased also by putting them to work. While interest rates are low, there are safe institutions in most communities that pay two to three per cent on deposits. Small-denomination government bonds pay fair returns on investments and can be converted into cash at any time desired. Other and more favorable opportunities may be found locally, but one should remember that safety and liquidity rather than high interest rates must govern all dispositions of capital savings. In a slow moving program such as this, one can not afford to risk losing one's savings.

Becoming a Tenant. Any young man who has gained the reputation of being a good farm hand and who has saved from his earnings a sufficient amount of capital to provide a good part of the equipment needed will have little trouble in renting a farm in most communities. It will be to his advantage to rent a farm that is in good condition. It is particularly desirable that the soil be productive, reasonably free from weeds, well-watered and provided, where needed, with adequate drainage. It will be well to keep in mind that income from farming is made from the soil and not from the buildings. Good buildings are desirable on any farm, but they are second in importance to productive soil. While working as a farm hand, the prospective tenant may be able to locate such a farm as he will be satisfied to operate. It is quite possible that a good farm hand, employed on a good farm, may in time operate it as a renter and eventually become the owner by purchase. More frequently those persons who would rent farms in a community stand ready to purchase any desirable farm offered for sale at what is regarded as a good bargain. In purchasing, the tenant should have in mind the type of farming he desires to follow, the size of farm he can handle to best advantage, and the possibility of paying for it from the earnings.

FORMS AND TERMS OF LEASE CONTRACTS

There are many variations in the form of lease contracts used in the United States. Within the same form there are many variations agreed to which must be written into the lease when drawn. Only a few of the standard forms will be discussed here for purposes of illustration. Those wishing to study forms of lease contracts for specific use may obtain copies of the forms commonly used in their community from county offices or from lawyers practicing in the community. Reference is also made to the discussion of legal relationships in farming, Chapter III. The forms in most common use are: (1) Crop Share, (2) Cash and Crop Share, (3) Crop and Livestock Share, (4) Cash. Crop-Share leases are probably more widely used than any other type and vary from locality to locality as custom and experience dictate. Discussion of some of the most common types follows.

CROP-SHARE LEASES

The ¼-¾ Crop-Share Lease. With this lease the landowner furnishes the land only, and frequently without buildings of importance. He gets in return for the use of the land on which he pays the taxes a ¼ share of all crops grown, delivered at the local market free of all expense. The tenant supplies power, machinery, equipment, all labor, seed, and feed. He also pays the cash costs for harvesting, threshing, and storing or marketing. For these contributions he gets a ¾ share of all crops grown. Under the Federal plan of controlled production and soil conservation the income from benefit payments is divided in the same proportion as the crops.

This type of lease is found most frequently on the margins of wheat and small grain-producing areas in the north and west. It is used among the cotton growers of the South also, under the name of "Share-Cropper's" lease, for the cotton crop, but supplemented to give the landowner ⅓ of any grain crops grown. Usually the landowner gives little attention to the handling of the land except to reach agreement with the tenant as to the crops to be grown.

The ⅓-⅔ Crop-Share Lease. This type of lease is quite common throughout the United States except where very high land values prevail.

Under this lease the landlord furnishes the land, usually equipped with a modest and inexpensive set of farm buildings. It is usual to require that all straw, cornstalks, or other crop residue be used on the farm where grown and that manures, if any, be spread on the land.

The tenant furnishes horse or other motive power, all machinery and equipment, seed, feed, and all man labor required. He also pays all expenses for harvesting and threshing the crops, including twine and cash threshing costs, but not the marketing cost of the landlord's share.

The crops to be grown should be mutually agreed upon and specified in the lease, subject to modification from year to year. Of the major crops grown the landlord receives ⅓ and the tenant ⅔ at the farm.

Small acreages used by the tenant for corn, potatoes, or other special crops may be paid for in cash as mutually agreed.

If land is to be seeded to grass, the landlord sometimes provides one half or all the grass seed and the tenant does the seeding. Hay cut from such seeding is usually put up by the tenant for which he gets a half share.

The ½ and ½ Crop-Share Lease. This form of lease is widely used throughout the Corn Belt and to some extent in many other parts of the United States. As with other leases, there are many variations in the terms as written into this lease in different communities, but the general terms are as follows:

1. The landlord provides the land and buildings, pays all taxes and insurance on real estate, furnishes the seeds of all kinds and pays one half the cash expense for threshing and, in some cases, one half the twine cost.

2. The tenant provides all horse or other power required, the machinery and equipment necessary in operating the farm, all man labor, and pays one half the cash expense for threshing and all taxes on his personal property.

3. The landlord receives one half of all grain crops delivered in bins at the farm or at a local elevator, if close by, as desired, also one half the hay in stack or mow as mutually agreed. If corn is raised, the landlord may choose between a half share unhusked in the field or ⅖ if harvested and cribbed by the tenant.

4. Should the tenant own some livestock for which pasture is needed, it is customary to pay cash rent for the acreage needed. Cash rent is frequently paid also for land needed for special feed crops, potatoes, or other cultivated crops. The custom is growing also of making a moderate charge against the tenant for the use of buildings and farmstead. The tenant in most cases is expected to feed his horses from his own share of the hay and grain. Sometimes, however, a liberal-minded landlord will consent to share equally with the tenant the cost of feed for the horses.

Cash and Crop-Share Lease. In areas where farming is well diversified and considerable livestock is raised by tenants, leases are frequently made which combine cash and crop-share payments. In such instances the tenant gives a one-third share of all grain crops raised for which he furnishes the seed and pays all expense. In addition he pays cash rent at an agreed price for all land used for corn, hay, pasture, or other feed or cultivated crops. The price paid varies with the quality of the land and the purpose for which it is used. Prices will range from five to eight dollars or more for high-conditioned corn land to one to three dollars for hay and pasture land.

CROP AND LIVESTOCK SHARE LEASE

Throughout the dairy and livestock regions of the United States a so-called 50-50 Crop and Stock-Share lease has been developed which is quite commonly used among the best farmers. This, like all other forms of lease, varies widely from area to area, from state to state, and even within states. Many features of the lease are quite general, however.

1. The landlord, under the best form of this lease, furnishes the land and buildings, including the house for the tenant. He also furnishes one half of all foundation herds of productive stock.

2. The tenant provides horse or other power, tools, machinery and implements unless otherwise agreed, all labor required to operate the farm, and one half of the foundation herds of productive stock.

3. Seed and feed for all livestock are provided from farm-grown supplies so far as possible. If either must be purchased, the expense is borne equally by the two parties to the contract. Should tractor power be used, the expense for fuel and oil should likewise be equally divided. The tenant, however, is expected to keep his power and machinery in repair at his own expense. Repairs and additions to jointly-owned equipment are a joint expense. The landlord furnishes the material for minor repairs on buildings and fences with the tenant furnishing the labor. Extraordinary repairs or improvements to real estate are borne by the landlord. Each party bears the taxes on individually owned property and shares equally the taxes on jointly owned property.

4. The income from all sales of crops, livestock products, and livestock are divided equally between the two parties. Each party is entitled to equal amounts of milk, cream, eggs, meat, or other farm-grown products for family use. Where one party uses more than the other, adjustments should be made at the end of the year.

5. Exceptions are made to the foregoing general policies in intensive dairy areas where the care of the dairy herd calls for a large amount of labor. In such areas it is quite common for the landlord to furnish all the cows and at least a half interest in the dairy bull. Where this practice is followed the owner's

foundation herd is maintained by replacement of the older or poorer cows with heifers from the growing young stock. Unless the tenant gets half the proceeds from the cows sold, the landlord should pay him for his half interest in any heifers drawn into the herd. Records and inventories are requisite for settlement.

LEASE FOR COMPLETELY EQUIPPED FARM

In rapidly increasing numbers farm owners are adopting the plan of renting a farm fully equipped with power, machinery, tools, implements, and all classes of livestock to which the farm is adapted. The tenant in such cases furnishes only the man labor required.

The income from a farm operated under this lease is divided between owner and tenant in proportion to the contributions made. On a farm devoted mainly to grain-growing a one-fourth share of the gross income would give adequate returns for the labor performed. Where some cattle and hogs are raised, a one-third share would be more equitable. On a farm heavily stocked with dairy cows, hogs, and poultry a two-fifths share would not give to the tenant more than reasonable return for the labor performed. The owner is expected to pay all operating expense except that required for the employment of labor.

This lease has certain advantages for young men who have little or no capital with which to start farming. Under a favorable lease of a good farm it should be possible, with good management, to earn more than hired-hand wages. Under an experienced farm owner living near by, assistance and direction can be given that will be helpful in planning production and producing and selling the products.

Naturally, a farm owner who risks his farm and livestock in the care of another will be careful in his selection of a tenant and somewhat exacting in the direction of the farm operations. Usually, this form of lease is made only when a prospective tenant has gained the reputation of being a good farmer and is known to be honest and reliable. It is sometimes used by a father who wishes to be relieved of the active labor of the farm and who has a son that is a competent farmer and wishes to start for himself.

THE CASH LEASE

In many of the richer agricultural areas where values of farm land are high, the cash lease is quite prevalent. This is a simple type of lease which, when the terms are once worked out and agreed to, gives the tenant almost complete control of the land so long as he carries out the agreement.

1. Under such a lease, the owner, for a cash consideration, puts at the disposal of the tenant his farm and buildings. In protection of the farm he should have written into the lease provisions for: (a) the maintenance of fertility through crop rotation and the use of manures, (b) the upkeep of buildings, fences, and other improvements, (c) the control of noxious weeds, and (d) the prevention of soil erosion. It is important, too, to know that the prospective tenant is honest, competent, and financially able to carry out his agreement.

2. The tenant provides at his own expense all power, equipment, livestock, feed, seed, supplies, and all labor required to operate the farm and make ordinary repairs. In fact, within the agreement carried in the lease contract, he operates the farm as though it were his own. He, of course, gets all products produced on the farm. Only tenants with a substantial accumulation of personal property and a moderate amount of capital can undertake this kind of a lease for a large farm.

TABLE I—ESTIMATED PROPORTIONATE EXPENSE TO LANDLORD AND TENANT IN PRODUCING SPRING WHEAT ON FALL-PLOWED LAND[1]

Item	Cost per acre Total	Expense Distribution			
		Half Share Lease		Third Share Lease	
		Landlord's expense	Tenant's expense	Landlord's expense	Tenant's expense
	Dollars	Dollars	Dollars	Dollars	Dollars
Seed—1¼ bu.	2.00	2.00			2.00
Man labor—12 hrs. @ 30c.	3.60		3.60		3.60
Horse work—15 hrs. @ 20c.	3.00	1.25*	1.75*		3.00
Twine	.32		.32		.32
Cash threshing	.56	.28	.28		.56
Machinery	1.50		1.50		1.50
Land use	3.00	3.00		3.00	
General expense	.75	.50	.25	.50	.25
Total	14.73	7.03	7.70	3.50	11.23

*Horses fed from undivided farm supply.

Such leases are popular with landowners who wish to be relieved of the active management of farms, and when competent and reliable tenants can be found. It is popular also among well-to-do tenants who wish to be relieved of constant supervision and interference by overzealous landlords.

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[1] The same form of Table can be used for any other crops, and a summary made of the end results.

DETERMINING FAIR EQUITIES IN SHARE LEASES

When can it be said that the terms of a share lease are fair to each party to it? How determine when each party is getting what he should have? An exact answer is not easy, but an approximate estimate can be made that will show the gross inequalities, if such exist. It is much easier to make such estimates if annual inventories are taken and reasonably complete records of all farm transactions are kept.

It is obvious and generally agreed that a farm operated under an equitable lease will return to each party a share in the products that is in proportion to the share he bears in the cost of production. Just what that share is can be told only from records kept or from careful estimates of comparative costs. These estimates will be most satisfactory if jointly worked out by both parties to the lease. Table I is a form that will be useful in accumulating the costs to each in crop production.

TABLE II—Proportionate Annual Expense per Cow in Maintaining a Dairy Herd Under a 50-50 Crop and Livestock Share Lease[1]

Item	Total Cost in Dollars	Distribution of Cost	
		Owner	Tenant
Feed Grain	1,500 lbs. @ 1c $15.00	$ 7.50	$ 7.50
Roughage	2 tons @ 10.00 20.00	10.00	10.00
Silage	2½ tons @ 3.00 7.50	3.75	3.75
Pasture	1 acre 3.00	1.50	1.50
Man labor	130 hrs. @ 25c 32.50		32.50
Horse work*	30 hrs. @ 15c 4.50	1.50	3.00
Cow cost	Int. Dep. & D. Risk 23.00	23.00	
Sire cost	Int. Dep. & D. Risk 4.00	4.00	
Equipment	1.00		1.00
Bedding	2 tons @ 1.00 2.00	1.00	1.00
Gen. expense	1.00	.50	.50
Overhead on bldgs.	5.00	5.00	
Total	$118.50	$57.75	$60.75

*Horses owned by tenant. Fed jointly.

A first draft shows that under the "half-share" lease the returns to each are reasonably equitable. Were the landlord to pay half the twine cost and share equally the cost for horse work, nearly a perfect balance would be reached. Under the "third-share" lease, however, the tenant does not get a fair deal. One third of the expense would be $4.91 per acre, but the landlord contributes only $3.50, which is $1.41 less per acre than his share. The tenant contributes $11.23, whereas two thirds of the expense per acre would be only \$9.82. He is, therefore, contributing \$1.41 more per acre than the lease calls for. A ¼ share to the landlord and a ¾ share to the tenant would be in better proportion to the contributions made than the ⅓-⅔ share lease proposed.

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[1] Hypothetical Example.

Similar estimates can be made covering proportionate costs of maintenance of a dairy herd, a herd of beef cattle, a swine herd, or other classes of livestock. Table II gives a list of the items that should be considered and an arbitrary estimate of the costs per cow to each, landlord and tenant, of maintaining a dairy cow on a 50-50 crop and stock share lease on a dairy farm where the landlord furnishes the cows and sire.

Analysis shows this to be a fairly equitable lease contract. The allowance for overhead charges for the buildings is probably lower than it should be. Cow costs and sire costs are based on cows valued at \$125.00 and a sire at \$300.00. If better-quality cattle are furnished, the landlord's share of the cost would be higher. The tenant's only chance to lower his costs is to reduce the hours of labor spent on cows, which is already very low.

Such estimates, made before a lease is consummated, will be helpful in setting up equitable terms under which to operate. Then a carefully-drawn lease, into which is written all the details of agreement and specification, will go far in avoiding misunderstandings, disagreements, and discontent.

THE TOP OF THE LADDER, A PURCHASED FARM

After a successful experience as a farm hand and as a tenant operator, one may well give consideration to the matter of purchasing a farm, provided that one wishes to stay permanently in the business of farming. Ownership of a good farm gives independence of action and freedom from irksome supervision from landlords or others. It also removes the uncertainty of tenure experienced in renting, and avoids the possibility of frequent interruption of operations and expensive moving. One should buy with care, however, as paying for a farm out of earnings is a long-time task. A false start and a bad bargain may be much worse than continuing as a tenant. The purchase of a family farm is a most important business transaction.

The Earmarks of a Good Farm. A long-time acquaintance with a farm and its past history affords the best knowledge of its value. Where that can not be had, there are other means of estimating its value. First, one should buy, if possible, in a well-developed community where thrifty farms and good buildings are in evidence. The productive power of the land in a community is usually expressed in the buildings found to prevail on the farms. Universally, good buildings are seldom found on infertile, unproductive land. Poor soils do not produce good buildings. A first impression of the quality of a community can be gained by a drive through it, and observing the condition of buildings and fields.

Location of a farm in relation to roads, markets, schools, churches, and neighbors is also important in the final selection of a farm. But of utmost importance is the quality of the soil. This may be clearly indicated by the nature of the trees, crops, or other vegetation growing on the land. Large, vigorous trees and heavy vegetation indicate a fertile, productive soil. One should also explore the soil as to depth, texture, and moisture content, and give consideration to topography, drainage, and freedom from stone. One should always keep in mind the fact that the soil produces the wealth of the farm.

As additional information, tax rates in the township should be checked and inquiry made as to special school, ditch, road, or other special taxes. Finally, it may be well to check judgment with a few experienced farmers in the neighborhood who know land values. Buying a poor farm is a costly experience.

When to Buy. The temptation to buy a farm is always strongest during a period of prosperity. The tendency at such times is to pay higher than normal prices for land. As paying for a farm is likely to be stretched over a period of ten to thirty years, it is quite likely that at least a part of the payments will be made in periods of depression, when prices of farm products are low and dollars are hard to get. It is better to continue as a renter on a good farm, if one can be had, during a boom time, and purchase a farm in a period of depression when a bargain can be found. Bargain for the farm in a depression period and pay for it during periods of general prosperity is a good rule to follow. But such a rule is not easy to follow, because it is difficult to tell how long a period of prosperity may last or just when or how fast it will break. There are signals, however, that may roughly serve as warnings of movements in the land market.

A period of rising prices and increasing farm incomes coupled with an increasing number of land sales is a danger signal. At such times the demand for land is strong and competitive bidding is likely to force prices up sharply. One who has little cash for a down payment should avoid buying at such times unless he knows he is getting the farm at a normal value and on favorable payment terms. Fortunately, such periods are favorable to tenants who are able to lease good farms. It may be better judgment to continue as a renter for a few years, if possible, and accumulate more equipment and capital rather than to attempt to purchase a farm on a rising market.

While it is hard to get up enthusiasm for farming during periods of low prices for farm products, the one who buys a farm at such times can get more for his money than the one who buys on a rising market. The capital accumulated as a tenant during good times will enable a larger down payment to be made. This larger payment adds to the safety of the investment and reduces the amount of interest to be paid. Much more peace of mind and freedom from worry can be had on a rented farm than on a farm heavily overburdened with debt. Some of the best farming in the world is done by tenant farmers.

The best bargain for a farm can usually be made with an owner who wants to sell. It is often possible to find an old couple who are left alone or have no children interested in farming and who wish to retire. Estates that are being settled sometimes present opportunities for buying at good values. Insurance company holdings, banks, and other lending agencies frequently afford good bargains in farm lands. All such possibilities should be carefully explored by the prospective purchaser. One wishing to make a wise purchase may well spend considerable time in searching for a farm that is adapted to his needs and that is owned by someone who wishes to sell.

How Much Is the Farm Worth? Having found what appears to be a desirable farm, it becomes important to know how much should be paid for it. One should obtain all possible available information about the farm. There are several sources where needed information may be gained.

1. Tax assessment records and tax levy records can be found at county seats. The records should be carefully studied. These will reveal taxes assessed against the farm in the past and show special tax levies or bonded indebtedness of the district for roads, drainage, school, or other purposes. Farms lying adjacent to villages or cities are likely to be included in a special tax district where rates are abnormally high, thus throwing a heavy tax burden upon them. Heavy taxes detract from the net income of a farm, and, therefore, reduce its value.

2. Information on the productive history of most farms can now be gained from the county AAA offices. The productivity rating of the farm, restrictions on the production program, and the acreage of soil-depleting and soil-building crops permitted or required can be learned from this source.

3. Soil survey bulletins are available for many counties. These give a description of the soils and a somewhat detailed classification by physical texture and topography.

4. Careful inquiry should be made as to past sales in the vicinity and prices paid for similar farms. Information on these points may be gained from neighbors and, to some extent, at the county courthouse.

5. United States Census reports give the average farm values by counties for farms of different sizes. These may be valuable in showing comparative values and as a basis for estimating how much above or below the average a specific farm is.

6. The most important source of information is the farm itself. A thorough physical examination of the farm under consideration is of the utmost importance. The purpose is to observe and appraise topography, drainage, soil, and other physical characteristics in relation to productivity. This information may then be used in estimating a fair rental price, or as a base on which an offer to purchase may be made. Obviously, the buildings should be checked to determine their suitability, the outlay, if any, needed to put them in condition for use, and the annual maintenance charge against the land.

Value Based on Income. In the final analysis, the value of a farm is based on the income it will produce. One way to determine a value or offering price on a farm is to figure the rent that a farm would bring either under the share or cash system. A rental bringing $3.00 an acre net rent is returning 4% on $75.00 land. At present money values, that is a higher rate than is being returned on government bonds or other long-time investments. A farm bringing a rental income of $2.00 an acre would not warrant payment of more than $50.00 an acre at a money rate of 4%. Because of particularly favorable location or other attractive features, the buyer may wish to offer somewhat more than is indicated by the rental value, or, in the hope of driving a favorable bargain, he may offer something less, particularly if he finds the owner anxious to sell. It is the net income value, however, that is likely to be available to pay the interest on the mortgage.

Down Payments on Purchase. The amount of the cash, or "down payment," on a farm will depend on the ability of the buyer to pay and the willingness of the seller to give credit. Some sellers insist on an all-cash payment. They usually will sacrifice something on the price for a quick cash sale. Few buyers, and particularly tenants, are prepared to buy for cash. The down payment, therefore, becomes a matter for bargaining between the two. Few sales are made with less than 10% of the selling price paid in cash. More frequently, 20% or more is required. If less than 20% of the selling price is paid in cash, it is customary for the seller to give a contract for a deed, and the seller to withhold the deed until 25% to 50% of the agreed price has been paid.*

As a matter of business policy, the buyer should make as large a down payment as possible, in order to avoid excessive interest charges. Buyers with limited capital, however, who must borrow heavily should bear in mind the sources of credit and the comparative cost of money for different purposes. Ordinarily, lower rates of interest can be obtained on long-time real-estate loans than on short-time chattel loans. It is advisable, therefore, to reduce as much as possible or eliminate entirely interest on short-time loans. Where one has livestock and equipment clear of loans and mortgages, a long-time amortized loan can usually be made on real estate at a low rate of interest. It is, therefore, good policy to continue to operate as a tenant until personal property has been cleared and sufficient cash has been accumulated to permit a down payment of at least 20% to 25% of the purchase price. An exception might be made at any time that a particularly productive farm can be bought at a bargain price. If credit must be sought, it will be well to negotiate with a number of loan agencies to learn where the most advantageous terms can be had. The sources of co-operative credit offered by the Production Credit Association, The Federal Land Bank and other units of the Farm Credit Administration are available for sound loans at low rates and on long-term amortization plans.

OTHER MEANS OF ACQUIRING A FARM

Three other methods of acquiring a farm have been passed over, but should be mentioned, though they do not enter into the present study. They are: (1) by Homestead Entry, (2) by Gift, (3) by Inheritance.

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* The nature of contract, deed, title, and other legal terms are discussed in Chapter III.

1. In the past, when the Federal Government held title to large areas of land, those who were willing to undergo the hardships of pioneer life could secure the right to a given property by Homestead Entry. It involved the payment of $1.25 an acre and the construction of certain buildings within a specified time. Free land of quality suitable for farming is no longer available, and opportunities for homesteading are rare and of meagre importance.

TABLE III—ACREAGE, YIELDS, AND TOTAL PRODUCTION OF EACH CROP AND AMOUNT AVAILABLE FOR USE OR SALE UNDER THREE DIFFERENT PLANS OF ORGANIZATION

		Budget I		Budget II		Budget III	
Crop	Yield per acre	Acres	Total yield	Acres	Total yield	Acres	Total yield
Oats	46 bu.	17.6	810 bu.	12.0	552 bu.		
Barley	40 bu.	9.4	376 bu.	15.5	620 bu.		
Oats and barley	54 bu.	9.2	497 bu.	25.5	1,377 bu.	41.0	2,214 bu.
Oats, barley and wheat	36 bu.	22.0	792 bu.				
Wheat	18 bu.	5.4	97 bu.				
Ear corn	58 bu.	17.2	998 bu.	14.0	812 bu.	31.5	1,827 bu.
Silage corn	9.0 T.	12.6	113.0 T.	13.5	121.5 T.	8.0	72.0 T.
Alfalfa, tim. and clover	1.4 T.	4.2	5.9 T.				
Alfalfa and timothy	2.0 T.	13.9	27.8 T.	25.5	51.0 T.	25.5	51.0 T.
Timothy and clover	1.1 T.	.9	1.0 T.				
Reed's Canary grass	3.4 T.	3.7	12.6 T.	4.1	13.9 T.	4.1	13.9 T.
Rotation Pasture		20.4		27.5		27.5	
Permanent pasture		10.8		10.8		10.8	
Total Concentrates—lbs.			157,780*		142,978*		186,972*
Total hay—lbs.			94,600		129,800		129,800
Total silage—lbs.			226,000		243,000		144,000

*An allowance for seed has been deducted. Corn is calculated at 56 pounds per bushel.

2. Acquirement by gift is comparatively rare and lies entirely outside of academic discussion or influence.

3. Acquirement by inheritance, while logical, desirable, and common in practice, involves a relatively small proportion of the farms of America. Partial inheritance is more common and involves partial purchases open only to members of a family group. No general discussion of these matters is needed here. For legal procedure in such matters see Chapter III.

A BUDGET TEST OF FARM EARNING POWER

A final check on the wisdom of the choice of farm for rental or purchase can be made by checking the earning power of the farm through an estimated budget test. A farm budget is a plan for the future use of the land, with an estimate of the prob-

TABLE IV—ESTIMATED FEED REQUIREMENTS FOR LIVESTOCK UNDER THREE DIFFERENT BUDGET PLANS OF ORGANIZATION

Class of Livestock	No.	Pounds per Unit				Total Pounds Feed				
		Concentrates	Hay	Silage	Milk	Concentrates	Hay	Silage	Whole Milk	Skim Milk
		BUDGET I								
Horses	2	2,600	2,850			5,200	5,700			
Dairy Cows	18	1,358	2,855	9,844		24,444	51,390	177,192		
Bull	1	750	3,000	4,000		750	3,000	4,000		
Heifers—2 years	5	600	3,000	2,500		3,000	15,000	12,500		
Heifers—1 year	5	400	2,000	2,000		2,000	10,000	10,000		
Calves—under 1 year	5*	200	750	500	336 wh. 2,540 sk.	1,000	3,750	2,500	1,680	12,700
Calves—veal	11				480				5,280	
Boar	1	600				600				
Sows—over 200 lbs.†	7	200				1,400				
Pigs	134 cwt.	440			735	58,960				98,490
Hens	250	75			20	18,750				5,000
Chicks	400	30				12,000				
Total Required						128,104	88,840	206,192	6,960	116,190
Total Available						157,780	94,600	226,000	6,960	116,480
		BUDGET II								
Horses	2	2,600	2,850			5,200	5,700			
Dairy Cows	25	1,358	3,335	8,404		33,950	83,375	210,100		
Bull	1	750	3,000	4,000		750	3,000	4,000		
Heifers—2 years	6	600	3,000	2,500		3,600	18,000	15,000		
Heifers—1 year	6	400	2,000	2,000		2,400	12,000	12,000		
Calves—under 1 year	6	200	750	500	336 wh. 2,540 sk.	1,200	4,500	3,000	2,016	15,240
Calves—veal	16*				480				7,680	
Boar	1	600				600				
Sows—over 200 lbs.†	9	200				1,800				
Pigs	156 cwt.	410			880	63,960				117,920
Hens	250	70			40	17,500				10,000
Chicks	400	30				12,000				
Total Required						142,960	126,575	244,100	9,696	143,160
Total Available						142,978	129,800	243,000	9,696	143,104
		BUDGET III								
Horses	2	2,600	2,850			5,200	5,700			
Beef Cows	20		3,382	4,855			67,640	97,100		
Bull	1		3,500	2,000			3,500	2,000		
Heifers—2 years	5		3,382	4,855			16,910	24,275		
Heifers—1 year	5		1,750	2,250			8,750	11,250		
Calves—under 1 year	5	400	750	750		2,000	3,750	3,750		
Calves—to 400 lbs.	14*	200	375	375		2,800	5,250	5,250		
Feeders—above 400 lbs.	84 cwt.	575	225			48,300	18,900			
Hens	250	77				19,250				
Chicks	400	30				12,000				
Boar	1	600				600				
Sows—over 200 lbs.†	15	200				3,000				
Pigs	213 cwt.	440				93,720				
Total Required						186,870	130,400	143,625		
Total Available						186,972	129,800	144,000		

*Estimated calf loss per year Budget I, 2; Budget II, 3; Budget III, 1.
†Gilts transferred from young pigs at 200 lbs.

able returns from each crop and class of livestock. It involves also an estimate of the amount of livestock to be kept, of the amount of feed required by them, of the pasturage needed, and of feed purchases. The hours of man labor and horse work should also be calculated as closely as possible and compared with the available supply. Against the income from all sources must be checked the probable costs and expenses for operation. The difference indicates approximately the net income that may be expected under the plan. Two or three alternative budgets should be set up showing the results from changed acreages of crops or different combinations of crops and livestock. The one offering the greatest returns for the labor and materials expended is the one that should, in the end, be adopted. A sample farm budget study is offered to illustrate its usefulness.

TABLE V—EXPENSES THAT VARY WITH DIFFERENT TYPES OF ORGANIZATION

Expense	Budget I		Budget II		Budget III	
	Quantity	Value	Quantity	Value	Quantity	Value
Crops:						
Alfalfa Seed @ $1.05 per A..........	13.5 A.	$ 14.17	25.5 A.	$ 26.78	25.5 A.	$ 26.78
Hog Pasture Mixture @ 65c per A.....	2.0 A.	1.30	2.0 A.	1.30	2.0 A.	1.30
Pasture Seed @ 84c per A...........	20.0 A.	16.80	25.5 A.	21.42	25.5 A.	21.42
Twine @ 22c per A.................	63.6 A.	13.99	53.0 A.	11.66	39.0 A.	8.58
Threshing..........................		90.56		89.56		73.71
Hybrid Seed Corn @ $6.00 per A......	2.4 bu.	14.40	2.0 bu.	12.00	4.5 bu.	27.00
Silage Corn Seed @ $2.00 per A......	4.2 bu.	8.40	4.5 bu.	9.00	2.6 bu.	5.20
Cash Expenses for Tractor—31c per hr.	194.0 hr.	60.14	168.0 bu.	52.08	178.0 hr.	55.18
Total..........................		$ 219.76		$ 223.80		$ 219.17
Livestock:						
Interest on Investment @ 5%........		137.80		180.05		141.85
Miscellaneous Cash Exp..............		37.00		49.00		28.00
Equipment Expense................		87.00		97.00		24.00
Tankage @ $50 per ton.............					4.26 ton	213.00
Total..........................		$ 261.80		$ 326.05		$ 406.85
Other Expenses:						
Hired Labor @ $44.50 per mo........	12 mo.	534.00	12 mo.	534.00	7 mo.	311.50
Board for Labor @ $16.00 per mo.....	12 mo.	192.00	12 mo.	192.00	7 mo.	112.00
Day Labor @ $3.00 per day..........			25 da.	75.00		
Board for Day Labor @ 50c per day...			25 da.	12.50		
Total..........................		$ 726.00		$ 813.50		$ 423.50
Total Variable Expenses..........		$1,207.56		$1,363.35		$1,049.52

The farm used in *Agriculture II* will be used for the budgets, since it is assumed that the student is already familiar with it. Assuming that this farm is for sale or rent, the prospective operator wants to know something of the earning power of the farm and which system of organization will give the greatest return.

Budget I assumes the original organization as shown on pages 27 and 38, *Agriculture II*, before revision of the cropping season, except that the power is furnished by a tractor and two horses, as suggested in Chapter IV, page 55 of *Agriculture III*.

Budget II is an organization using the revised cropping system as shown on pages 46 and 47 of *Agriculture II*. The dairy herd is increased by seven cows and two more sows are kept.

This plan utilizes all the feed produced on the farm. The power is furnished in the same way as in Budget I.

Budget III shows a beef breeding herd of 20 cows. The calves are to be born in the spring and run with the cows on pasture during the summer. Five calves are to be kept for replacements of cull cows and the loss of one calf per year is expected, leaving 14 head to be put in the dry lot and fed out as baby beeves. Fifteen sows will be bred to farrow in April with two bred for fall pigs to follow the feeding cattle. The cropping system is the same as that shown in Budget II, except that 1½ fields are used for corn and 1½ fields are used for small grain. The investment in feed bunks, outside racks for hay, and remodeling of barn (removal of stanchions, etc.) will about offset the investment in dairy equipment.

TABLE VI—Estimated Income Under Each Budget

Source	Budget I		Budget II		Budget III	
	Quantity	Value	Quantity	Value	Quantity	Value
Dairy:						
Butterfat @ 28c per lb.	4,320 lbs.	$1,209.60	6,000 lbs.	$1,680.00		
Cull Cows @ $35.00 each	5	175.00	6	210.00		
Veal Calves @ $15.00 each	11	165.00	16	240.00		
Total		$1,549.60		$2,130.00		
Beef Cattle:						
Cull Cows @ $33.00 per head					5	$ 165.00
Baby Beeves @ $8.00 per cwt.					14,000 lbs.	1,120.00
Total						$1,285.00
Hogs:						
Sows @ $5.00 per cwt.	2,450 lbs.	122.50	3,150 lbs.	157.50	5,250 lbs.	262.50
Pigs @ $6.50 per cwt.	12,000 lbs.	780.00	13,800 lbs.	897.00	18,300 lbs.	1,189.50
Total		$902.50		$1,054.50		$1,452.00
Poultry:						
Springs @ 40c each	125	50.00	125	50.00	125	50.00
Old Hens @ 35c each	50	17.50	50	17.50	50	17.50
Eggs @ 16c per doz.	2,470 doz.	395.20	2,470 doz.	395.20	2,470 doz.	395.20
Total		$462.70		$462.70		$462.70
Crops:						
Barley @ 45c per bu.	599 bu.	269.55				
Total Receipts		$3,184.35		$3,647.20		$3,199.70
Less Variable Expenses		1,207.56		1,365.85		1,049.52
Total		$1,976.79		$2,281.35		$2,150.18

The organization under Budget I requires the labor of two men but does not make full utilization of this labor. The work is distributed in such a way that the hiring of a man during the crop season will not solve the problem, because it will leave too much for one man during the balance of the year. The organization under Budget II utilizes more fully the labor of the operator and one full-time hired man. The labor requirements of the organization shown in Budget III can be handled by the operator, except during the crop season. A man would need to be hired for seven months.

Only the expenses that vary with changes in the organization have been shown in the budgets. For example, in comparing Budget I with Budget III, note that the twine cost is much higher in Budget I, because more small grain is raised. More corn is raised under the system shown in Budget III, consequently the cost of hybrid seed is about twice as much as for Budget I. The returns shown by the three budgets do not show how much money the operator will have to spend but show the relative returns to be expected by each of the three methods of operating the farm under normal operating conditions.

In comparing the returns above, variable expenses are shown in the three budgets. Budget I shows $1,976.79, Budget II, $2,281.35, and Budget III, $2,150.18. This variation does not represent the money available to spend but shows that returns from Budget II are $304.56 more than from Budget I, and $131.17 more than from Budget III. It also shows that returns from Budget III are $173.39 more than from Budget I.

The other items of expense such as rent, interest, taxes, insurance, upkeep, and depreciation on buildings and machinery, and miscellaneous expenses would be the same whether the farm was operated as a dairy farm according to Budget I or whether it was operated as a beef-breeding farm according to Budget III. In order to arrive at a figure showing the amount of money available to the operator for spending, it would be necessary to include the above expenses with the variable expenses shown in the budgets for a fair comparison.

The prices used in the budgets for products sold are the average for the period 1930-1939. There is only a small difference of $131.17 between operating the farm as a dairy farm, as shown in Budget II, or as a beef-breeding farm, shown in Budget III, when these prices are used. The choice of organization in this case would very likely rest with the preference of the operator for dairy farming or beef farming. Different prices might have an important effect on the choice of organization for this farm. If the butterfat prices used in the budgets had been 35c per pound and all other prices had remained the same, then the returns from the dairy organization shown by Budget II would have been $2,701.35, or $550.17 more. If the butterfat price had been 20c a pound and the price of beef unchanged, then the returns from the beef-breeding organization would remain at $2,150.18 and the returns from dairying represented by Budget III would have been $1,801.35, or $348.83 less. Similar comparisons can be made by varying the price received for hogs or beef cattle or by varying weights or quality.

The suggested budgets have in no way exhausted the possibilities of organization on this farm but have served merely as examples of the method. A prospective operator would undoubtedly want to try others. Errors made in selecting the wrong kind of organization are not so serious when made on paper, since the trial plan of organization can easily be discarded; but, if the wrong kind of organization is actually set up on a farm, it may eventually end in bankruptcy. The budget method offers an inexpensive way of trying out different systems of organization to determine the most profitable way of organizing a particular farm business.

FATHER AND SON FARM-PARTNERSHIP AGREEMENT*

This agreement is entered into this..day of
.... 19...., by and between..
the father, and..
.... the son(s).

A. Purpose of the Partnership and Length of Term

The aforesaid parties do hereby form a partnership for the purpose of operating the farm business on the following described real estate situated in the County of..............................and the State of..............................
to wit:..

The term of this agreement shall be..........................year(s), from........
.... 19...., to.. 19..... This agreement will continue in effect from year to year thereafter until written notice of termination is given by either party on or before the....................
.... day of...................................... (month) before expiration of this agreement.

B. General Plan of Operation

1. **Participation in Management and Drawing Accounts:** It is the general plan (a) that the father and son will each contribute of his own labor and management to the partnership to the extent that he is able, and (b) that each party will receive a nominal monthly wage allowance or drawing account, the amount to be in proportion to the labor and management contributed by each, and to the anticipated financial returns from the farm business for the year.

2. **Farm Records:** Farm inventory and cash records shall be kept and these records shall serve as the basis of the annual settlement. At the beginning of this agreement, an appraisal will be made of the value

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* Prepared by E. B. Hill, Farm Management Department, Michigan State College, East Lansing, Michigan.

of the farm as a unit, and of the farm improvements, such as the buildings, windmill, fences, building material, and orchard separately. An inventory statement showing ownership, amounts, and estimated values of the livestock, machinery, feed, growing crops, and supplies on the farm is to be made at the beginning of this agreement, and at the end of each year thereafter. (The Michigan Farm Account Book is recommended as a suitable book on which the farm inventory and cash records may be recorded.)

3. **Farm Improvements:** Buildings, fences, wells, drains, and other improvements added to land owned by the father are to be from money and labor furnished by the father. A record will be kept of all labor and cash expenditures on such construction. Should any contribution of money and labor be made by the son in the construction of new buildings, fences, wells, and drains, or on improvements on such property, such contributions will become a lien on the aforesaid farm and will be payable to him in case of dissolution of this partnership or in case of a settlement of the estate.

Commercial Orchards: Trees for new orchards will be furnished one half by the father and one half by the son. Each party is to share equally in the net increase or decrease in orchard values during the period of this agreement. (At the beginning of the agreement a detailed inventory of the orchard should be made to show the number, ages, and value of trees by blocks.)

4. **Ownership of Personal Property:** The son is to buy from the father a one-half interest in the young livestock, the work horses and other mature livestock, the machinery and equipment, and in the feed, crops, and supplies on hand at that time. Payment may be made by the son by giving his note and then making payments monthly and whenever any of said stock, crops, or machinery is sold. (In lieu of participation in ownership of **the work horses, other mature livestock, machinery and equipment, and truck and tractor,** the son may pay the father for the use of the father's share of such property by paying him interest on the investment at the beginning of each year. In some cases, allowances for depreciation should also be made to the father on such of the property as he may own in excess of that owned by the son.) It is recommended, however, that the son buy or otherwise provide a one-half interest in the young stock on the farm at the beginning of this agreement.

5. **Reimbursement for Living Expenses:** The son is to pay $.. each month for laundry, and for his share of the cash cost of purchased food and fuel if he continues to live with his father and mother. (Since the son is an equal partner in the farm business, he is entitled to living quarters and to one half of the food and fuel produced by the farm.)

6. **Sales and Purchases:** The time and place where farm products shall be sold shall be mutually agreed upon by the father and son. No sale of farm products or purchase of farm equipment, livestock, or supplies exceeding $.. is to be made by either party before obtaining the consent of the other party.

C. Sharing Expenses and Returns

1. **Cash Receipts:** The total cash farm receipts shall be the sum of the receipts from the sale of livestock owned in common, livestock products, crops, and such miscellaneous receipts as may be agreed upon by both parties. The cash receipts as received during the year shall not be

divided as they are received, but rather put in a checking account or otherwise kept in a joint fund.

2. **Cash Expenses:** Total cash farm expenses shall include the sum of the following: livestock purchases; feed purchases; livestock expenses; crop expenses; hired labor; taxes and cash rent; expenses for repair, insurance, and maintenance of all farm improvements such as the farm buildings, drains, fences, and water supply; purchase of new machinery and equipment; power and machinery expenses; telephone; electricity; and such miscellaneous expenses as may be considered to be a part of the farm operating expense. All these expenses in addition to the monthly wage allowance to each partner shall be paid out of the joint partnership account either by check or otherwise. (If one partner for any reason finds it necessary to withdraw an amount in excess of his monthly wage allowance, a record should be kept of this transaction so that it may be equalized when the annual settlement is made.)

3. **Determination of Net Farm Returns:** Net farm returns will be the amount left in the joint account after paying all cash expenses including the monthly wage allowance for each partner.

4. **Annual Settlement:** The net farm returns shall be divided as follows: The partner who has the largest capital investment shall receive ....% interest on the capital that he has invested in excess of the capital invested by the other partner. The balance of the net farm returns shall be divided equally between the partners.

D. Division of Property at End of Partnership

At the expiration of this partnership, all property owned in common will be appraised jointly by both parties. Settlement will be made on the basis of the share of ownership of each party. If actual division of the property, however, is not possible or desirable, the father agrees to buy the son's share, or to sell his own share at the appraised value.

E. Arbitration

The parties hereby agree to submit to arbitration all differences they themselves cannot settle which may arise under this lease. The arbitration hereby agreed to shall be made by a board of three men, one chosen by each party and the third by the two so chosen. The decision of a majority of the arbitrators shall be final and binding upon both parties to this contract except if a matter of law or a sum exceeding $.. is involved.

IN WITNESS WHEREOF, the parties hereto have affixed their signatures the day and year first above written.

....	....
(Witness)	(Father)
	....
	(Mother)
	....
	(Son)

The foregoing sample of agreement is not offered as suited to all types of farming. It is illustrative only of the principles involved in an equitable contract and may serve as a pattern around which to develop a form of agreement for specific but varying situations. Teachers and pupils together may well attempt to work out forms suitable to the local environment.

Suggestive Questions

1. How many farms are represented by the students in your class?
2. How many of these farms are owned by the operators?
3. What is the process known as "climbing the agricultural ladder"?
4. How many kinds of leases are discussed in the text of this chapter?
5. What are the "earmarks" of a good farm?
6. What importance do you attach to the soil as a factor in earning farm income?

Suggestive Activities

1. List the names of students in your class who are doing home-project work and state the type of project.
2. Learn by inquiry how many farmers represented by students in your class live on rented farms.
3. How many different forms of lease are there in the group?
4. Check the contributions made by each party to the lease. See Table I, page 25.
5. If possible, estimate the value of contributions of each party and the equity of the returns to each.
6. Make a budget list of the probable requirements and returns for some farm for which you have the necessary data and information.

CHAPTER III

LEGAL MATTERS RELATING TO FARM BUSINESS

Farmers, as a rule, are not much concerned with law, as they have only occasional contact with lawyers and courts. It is important, however, that they have knowledge of the legal matters that relate to farm business procedures and the current transactions of every-day farm life. The discussion following is not intended as legal advice, but is presented only with the view that it may prove helpful to those engaged in farming as a means of livelihood. It is wise, if not absolutely necessary, when buying a farm, leasing property, or transacting other business of importance to engage someone well versed in the law to examine the title and draw up the legal forms required in the transaction. The party that buys as well as the party that sells should have a clear understanding of the steps involved and of the responsibilities of each to the other. Farmers should be well informed about farm leases, real estate and chattel mortgages, promissory notes, checking accounts, and other forms of legal papers commonly used in connection with farming. Consideration will first be given to the property rights involved in buying a farm.

Real Property. In the eyes of the law, *Real Property*, usually designated as *Real Estate*, is land or an interest in land. The term is much broader in its meaning, however, than land only. It also includes anything which is permanently attached or annexed to the land, such as buildings, wells, windmills, fences, trees, grass, or growing crops.

Personal Property is everything not classed as real property, such as furniture, stored grain or hay, tools, implements, horses, cattle, and other livestock, or other movable property not definitely attached to the land. Under certain circumstances personal property may become part of the real estate, in which case such property is called a fixture or fixtures.

Fixtures are articles of personal property which have become part of the real estate to which they are actually or constructively attached or annexed. Windmills, fences, hay carrier tracks, and similar articles are examples of fixtures.

It is sometimes difficult to determine whether or not a certain unit of property is a fixture or whether it retains the character of personal property. For this reason many disputes come before the courts. For example, Jones, a tenant, at his own expense, on the farm he has leased builds a corncrib which he says is a temporary structure. The owner of the farm leased by Jones sold it to Brown. Brown thought the corncrib was one of the buildings of the farmstead and that he had bought it with the land. A dispute could easily arise in this statement of facts. Questions of this kind frequently arise between landlord and tenant, purchaser and seller, and mortgagors and mortgagees.

The principal test as to whether personal property becomes a fixture or not rests mainly with the intention of the parties at the time of the annexation. This intention is not merely mental, for intent alone, without actual annexation, will not convert personal property into real estate. The intention, if not expressed in writing or before witnesses by the parties concerned, will be considered from the facts in the particular case. The courts mainly consider two points in determining such questions.

1. The relationship of the person annexing the property to the real estate, whether as a tenant or an owner. If the owner annexed personal property to real estate, the intent that such should be part of the real estate is stronger than if a tenant attached such property.

2. The manner in which the personal property is annexed—can it be removed without causing material damage to the real estate?

Summarizing this brief statement on the subject of fixtures, it may be said that, if personal property becomes so attached to the real estate as to be a fixture, that property passes with the real estate when it is sold or rented.

BUYING A FARM

Under the Statute of Frauds, enacted by most states, contracts for the sale of land or any interest in land must be in writing. An oral agreement to sell land or any interest in land can not be enforced. This rule of law is a good point to follow in considering the purchase of a farm. Naturally, one must first find an owner who is willing to sell his farm on the terms that a purchaser is able to meet. When such a prospect seems favorable, one should make a complete inspection of the farm, preferably with some person whose advice is regarded sound. Some of the tests of a good farm are location in relation to churches, schools, and town, the condition of roads, the type and condition of soil, drainage, buildings, and fences. Check also whether or not the farm is free from noxious weeds. In making this survey observe carefully any articles such as brooder houses, temporary granaries, water pipes, haying equipment in barn, or any other articles that might be questionable as to whether or not they are fixtures. The next step is to determine the amount of taxes levied against the farm. Make an inventory of these items and investigate each one thoroughly.

One is then ready to negotiate with the owner as to the purchase price and the terms of sale. The discussion should cover also the inventory of questionable items, but one is not yet ready at this point to complete the transaction, since information is needed about the rights of title possessed by the owner.

Earnest-Money Contract. While a check of the title is being made, a preliminary instrument in writing, known as an Earnest-Money Contract, should be executed in order to bind both seller and purchaser to any agreement that has been reached. Many persons regard the Earnest-Money Contract as merely a form and pay little or no attention to its preparation. In fact, it is the most important instrument in the entire transaction, since it is the basis for other instruments which follow, such as a Warranty Deed or a Contract for Deed, and other documents or papers related to the transaction. This is the instrument that should define the questionable items, such as the temporary granary, the hay equipment in the barn, the water pipes, electric equipment, and all other items that may be of doubtful classification.

The Earnest-Money Contract should show:

1. The correct names of the parties.
2. An accurate description of the real estate.
3. The purchase price, the manner of payment, and the rate of interest, if interest is to be paid.
4. Any special provision, such as an inventory of personal property included in sale of real estate.
5. The type of deed to be given.
6. Agreement as to furnishing a complete Abstract of Title by the seller.
7. A time limit on examination of abstract and period within which title must be made good by seller.

Also, the Earnest-Money Contract usually provides for retention, by seller, of the earnest money paid, if the purchaser fails to carry out the contract.

EXHIBIT A. EARNEST-MONEY CONTRACT

EARNEST MONEY CONTRACT OF SALE

Duluth, *Minn.* April 15, *19*42

Received of Frank J. Brown

One Hundred and no/100 - *DOLLARS,* *($*100.00 *), as Earnest Money, and in part payment for the purchase of the following described property situated in the county of* St. Louis *and State of Minnesota, viz:*

The West Half of the Southwest Quarter of the Northeast Quarter (W½ of SW¼ of NE¼) of Section Eight (8), in Township Fifty-one (51) North of Range Thirteen (13) West of the 4th P.M., St. Louis County, Minnesota.

which I *have this day, through* Matthew J. Finley, my *authorized agent , sold and agreed to convey to said* Frank J. Brown *for the sum of* Two Thousand and no/100 - - - - - - - - - - - - - - - *Dollars, ($* 2,000.00 *),* *on terms as follows, viz:*

One Hundred and no/100 - - - - - - - - - - *Dollars ($* 100.00 *), in hand paid as above, and* Nineteen Hundred and no/100 Dollars upon the execution and delivery to the buyer of ~~*payable on or before the dates named above, or as soon thereafter as*~~ *a Warranty Deed conveying a good title to said land*~~*, is tendered,*~~ *time being considered of the essence of this Contract.*

It is understood that complete abstract of title continued to date is to be furnished to purchaser at the expense of vendor , after which 5 *days is to be allowed purchaser for examination of title and report*

*Such purchaser agree*s *to pay all taxes or assessments, or installments thereof, that may hereafter become payable on said property from date hereof, including unpaid installments of special assessments heretofore levied on said property.* It is mutually agreed between the parties that the following articles are a part of the Real Estate described herein:
(1) 6 portable v-type hog houses, (2) 1 temporary corncrib, 1 brooder house, all water pipes used in conducting water from the well to the barn. All rope, pulleys, and hay slings and fork now in the barn.

And it is agreed that if the title to said premises is not good and cannot be made good within sixty days from date hereof, this agreement shall be void, and the above One Hundred and no/100 - - - *Dollars ($* 100.00 *) refunded. But, if the title to said premises is now good, in the name of the vendor , or is made good to him within sixty days, and said purchaser refuses to accept the same, said* One Hundred and no/100 - - - - *Dollars ($*100.00 *) shall be forfeited to the vendor. But it is agreed and understood by all parties to this agreement that said forfeiture shall in no way affect the right of either party to enforce the specific performance of this Contract.*

- It is especially understood and agreed that this sale is made subject to approval by the owner of said premises in writing and that the undersigned Matthew J. Finley *agent , is in no manner liable or responsible on account of this agreement except for the return of said earnest money as herein provided.*

By .... *Agent*

I *hereby agree to purchase the said property for the price and upon the terms above mentioned, and also agree to the conditions of forfeiture and all other conditions therein expressed.*

I *the undersigned, owner of the above described land, do hereby ratify the above sale and agreement.*

The Earnest-Money Contract should be signed by the seller and the purchaser, and, while it is valid as between the parties if not witnessed or notarized, it is well to have such instrument properly witnessed and acknowledged by a notary or other officer eligible to take acknowledgements.

Examination of Title. There should then be a careful examination of the title. The Abstract of Title should be continued by the seller to the date of sale, so that all recorded instruments affecting the title will be shown. The making or continuation of the abstract is usually done by an abstractor, a person skilled in making a search of the records. He will note whether or not any new instruments have been filed since a previous abstract was completed. The abstract is really a history book of the land. It traces the title of ownership from the first person who owned the land to the present owner. It gives a brief statement of the deeds, mortgages, liens, judgments, probate proceedings, foreclosures, and the parties named and concerned in all the instruments.

This basic information, together with a careful search of the instruments on file, will enable a lawyer, whose services the purchaser should secure, to determine whether or not the title is good. Usually the abstractor will furnish a statement concerning the unpaid taxes against the property and a judgment* search relative to all persons who may have had an interest in the land during a stated period. This period differs in the various states. For example, in Minnesota a judgment is effective against a person for a period of ten years and becomes a lien against all his real estate located in the county where the judgment is filed, exception being made in certain cases involving the homestead. For this reason, one will want to know whether or not former owners are free from judgment. If the services of a lawyer are secured, as they should be, he will write an opinion after he examines the title, stating the condition of the title. If the title is defective, the seller, under the terms of the Earnest-Money Contract, is required to clear such defects within a prescribed time. If title is good, the opinion will direct attention to the fact that certain matters such as mechanics' liens and interests of parties in possession, while not appearing in the abstract, may affect the title. For example, any person contributing labor and material toward the improvement of the real estate

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* A judgment results from a lawsuit between two or more parties. It is the formal declaration of the rights of the parties as determined by the trial.

EXHIBIT B. Extract From Abstract of Title

27

For Articles of Incorporation of the Woodland Company, see Book S of Miscellaneous Records, page 2.

28

150 Mtgs. Page 466	Woodland Company, Plaintiff, —Vs.— Motor Line Improvement Company, et al., Defendants.	Lis Pendens In District Court, 11th Judicial District, St. Louis County, Minnesota: Dated June 29, 1899. Filed June 29, 1899, 11 A. M. The object of this action is to declare plaintiff owner in fee of the NE¼ of Section 8, Township 51, Range 13, and other land.

29

177 Deeds Page 132	Woodland Company, —Vs.— Motor Line Improvement Company, et al.	Final Decree In District Court, 11th Judicial District, St. Louis County, Minnesota: Dated September 23, 1899 Filed September 23, 1899, 11:30 A. M. Adjudged and decreed that plaintiff is owner in fee of the NE¼ of Section 8, Township 51, Range 13, and other land.

30

305 Deeds Page 227	Woodland Company (a Wisconsin corporation) by President and Secretary (Corporate Seal) —To— C. Francis Colman.	Warranty Deed Dated July 1, 1909 Filed August 24, 1909, 11 A. M. Conveys the NE¼ of Section 8, Township 51, Range 13.

31

268 Mtgs. Page 19	C. Francis Colman, —To— Woodland Company (a Wisconsin corporation).	Mortgage Dated July 1, 1909. Filed July 14, 1909, 4:45 P. M. Consideration $1,800.00, three notes of $600.00 each, due on or before one, two, and three years, with interest at 6% payable semi-annually. Conveys the NE¼ of Section 8, Township 51, Range 13. Given for part purchase money.

CORPORATE SEAL

has a lien against the land for payment of the cost of such improvements. Such persons are not required to file their lien or liens immediately upon completion of improvements, but are given a period of time within which a written statement must be filed. The time for filing such lien, or liens, is determined by the statutes of the state wherein the land is situated. If there is evidence that work has been done recently, the seller should be asked to show paid receipts or give a surety bond indemnifying the buyer against loss suffered by any liens that may later be filed against this property. The purchaser is charged with the responsibility of making inquiry as to the interests any person or persons residing upon or in possession of the land may have. For example, the occupant may have a lease which is not filed or he may have an unrecorded deed for the land. Either of these contingencies, if actual, would affect the title and perhaps delay transfer of title and occupancy. Then, too, certain persons may have acquired, by reason of use for a long period, rights such as easements in the use of a roadway passing through the land. These are some of the problems which must be considered when entering into the purchase of real estate.

Transfer of Title. If the title has been found to be without defect, the seller, upon payment to him as provided by the Earnest-Money Contract, will execute a deed transferring ownership. There are two types of deeds, (1) Warranty Deed and (2) Quit-Claim Deed.

There are several forms of deeds. It is necessary to note carefully the different situations covered in each form.

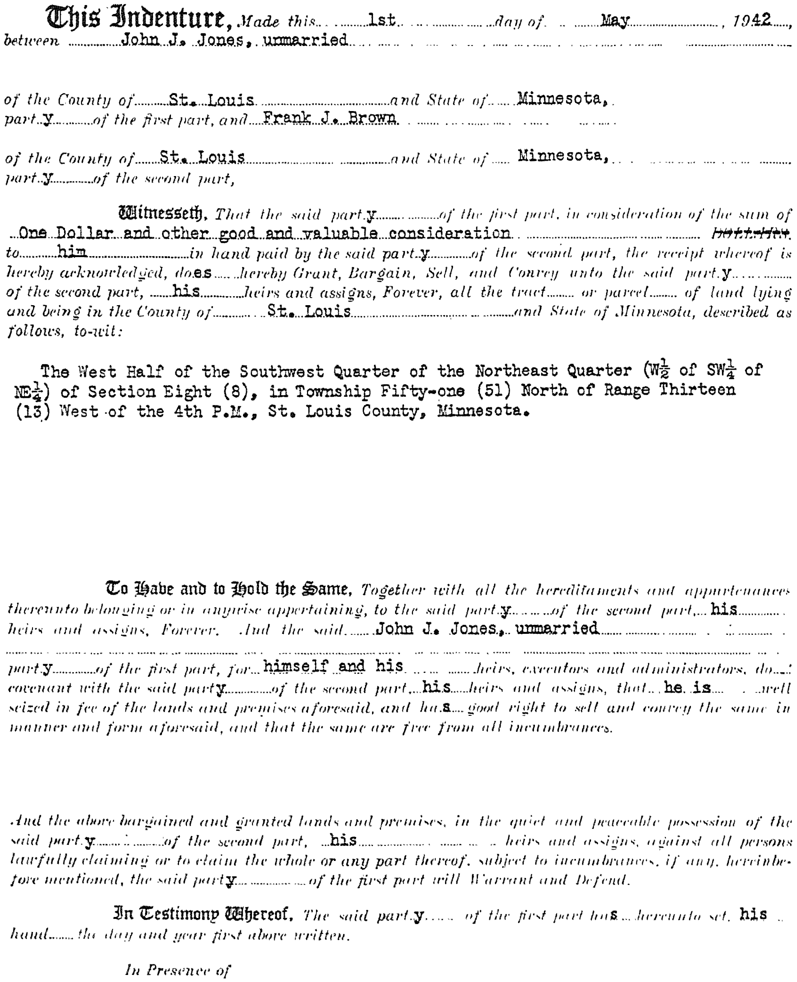
TYPES OF DEEDS

Warranty Deed. As shown in the illustration, a Warranty Deed contains the following covenants, the seller in this case being the grantor and the purchaser the grantee.

1. That the grantor owns the premises.
2. That he has good right to convey the same.
3. That the premises are free from encumbrances (except as stated).
4. That the grantee shall not be disturbed in his quiet possession of the premises by reason of any defect in the title, and
5. That the grantor will warrant and defend the grantee against eviction by anyone who may prove to have a better title.

While the covenants expressed in a Warranty Deed are definite, it is not good practice to depend wholly upon these warranties, since the financial responsibility of the party with whom one may be dealing determines whether or not he can support such declarations. Many purchasers, relying entirely upon the Warranty Deed, fail to have the title examined by a competent examiner. The difficulty with this manner of dealing is something like "locking the barn after the horse is stolen." If the title

EXHIBIT C. WARRANTY DEED



This Indenture, *Made this* 1st *day of* May, *1942*, *between* John J. Jones, unmarried

of the County of St. Louis *and State of* Minnesota, *party of the first part, and* Frank J. Brown

of the County of St. Louis *and State of* Minnesota, *party of the second part,*

Witnesseth, *That the said party of the first part, in consideration of the sum of* One Dollar and other good and valuable consideration ~~Dollars~~, *to* him *in hand paid by the said party of the second part, the receipt whereof is hereby acknowledged, does hereby Grant, Bargain, Sell, and Convey unto the said party of the second part,* his *heirs and assigns, Forever, all the tract or parcel of land lying and being in the County of* St. Louis *and State of Minnesota, described as follows, to-wit:*

The West Half of the Southwest Quarter of the Northeast Quarter (W½ of SW¼ of NE¼) of Section Eight (8), in Township Fifty-one (51) North of Range Thirteen (13) West of the 4th P.M., St. Louis County, Minnesota.

To Have and to Hold the Same, *Together with all the hereditaments and appurtenances thereunto belonging or in anywise appertaining, to the said party of the second part,* his *heirs and assigns, Forever. And the said* John J. Jones, unmarried *party of the first part, for* himself and his *heirs, executors and administrators, do covenant with the said party of the second part,* his *heirs and assigns, that* he is *well seized in fee of the lands and premises aforesaid, and has good right to sell and convey the same in manner and form aforesaid, and that the same are free from all incumbrances.*

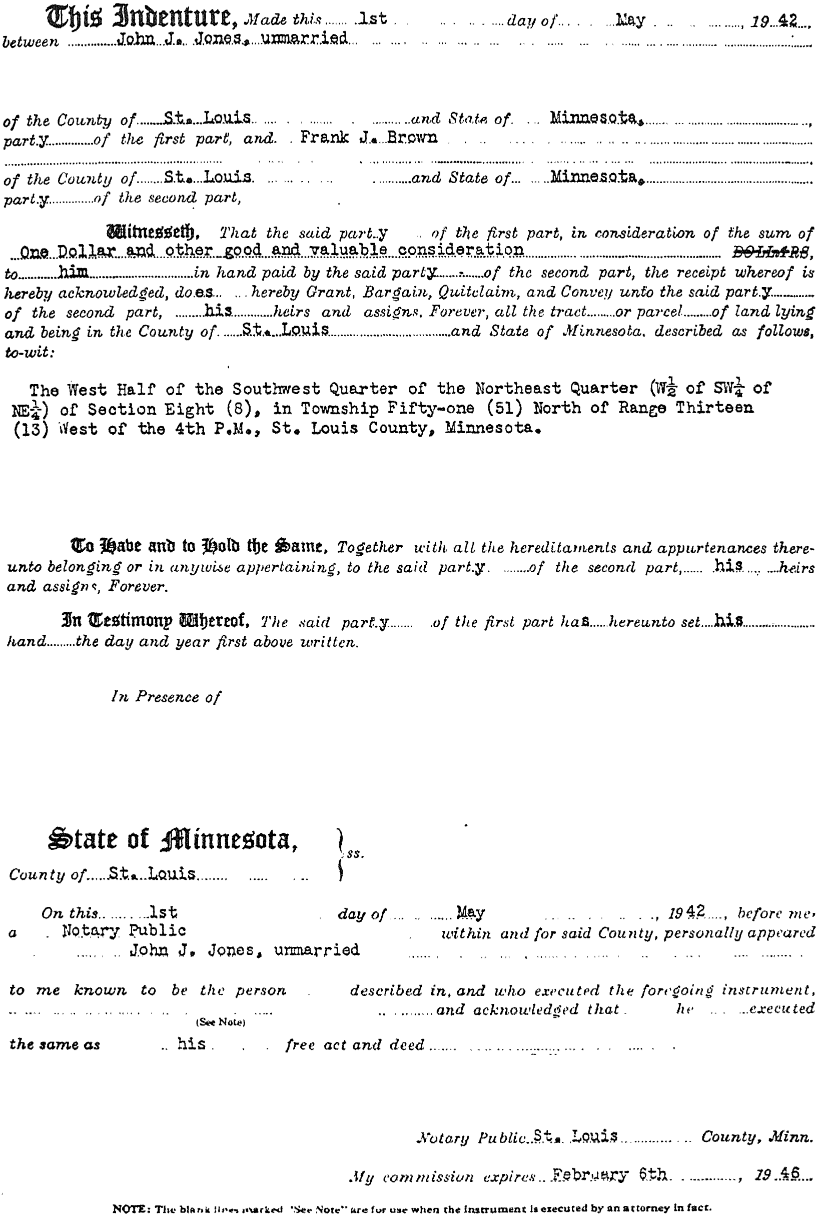
And the above bargained and granted lands and premises, in the quiet and peaceable possession of the said party of the second part, his *heirs and assigns, against all persons lawfully claiming or to claim the whole or any part thereof, subject to incumbrances, if any, hereinbefore mentioned, the said party of the first part will Warrant and Defend.*

In Testimony Whereof, *The said party of the first part has hereunto set* his *hand the day and year first above written.*

In Presence of

later proves defective, there is no assurance that the grantor can be found or is able to make good his warranties. If found, he may be financially irresponsible and, in any event, a lawsuit to enforce the contract is not a pleasant undertaking and involves additional expense.

EXHIBIT D. QUITCLAIM DEED



This Indenture, *Made this* 1st *day of* May, *19*42, *between* John J. Jones, unmarried

of the County of St. Louis *and State of* Minnesota, *party of the first part, and* Frank J. Brown

of the County of St. Louis *and State of* Minnesota, *party of the second part,*

Witnesseth, *That the said party of the first part, in consideration of the sum of* One Dollar and other good and valuable consideration ~~DOLLARS~~, *to* him *in hand paid by the said party of the second part, the receipt whereof is hereby acknowledged, does hereby Grant, Bargain, Quitclaim, and Convey unto the said party of the second part,* his *heirs and assigns, Forever, all the tract or parcel of land lying and being in the County of* St. Louis *and State of Minnesota, described as follows, to-wit:*

The West Half of the Southwest Quarter of the Northeast Quarter ($W\frac{1}{2}$ of $SW\frac{1}{4}$ of $NE\frac{1}{4}$) of Section Eight (8), in Township Fifty-one (51) North of Range Thirteen (13) West of the 4th P.M., St. Louis County, Minnesota.

To Have and to Hold the Same, *Together with all the hereditaments and appurtenances thereunto belonging or in anywise appertaining, to the said party of the second part,* his *heirs and assigns, Forever.*

In Testimony Whereof, *The said party of the first part has hereunto set* his *hand the day year first above written.*

In Presence of

State of Minnesota, } *ss.*
County of St. Louis }

On this 1st *day of* May, *19*42, *before me, a* Notary Public *within and for said County, personally appeared* John J. Jones, unmarried

to me known to be the person described in, and who executed the foregoing instrument, (See Note) *and acknowledged that* he *executed the same as* his *free act and deed*

Notary Public St. Louis *County, Minn.*

My commission expires February 6th, *19*46

NOTE: The blank lines marked "See Note" are for use when the instrument is executed by an attorney in fact.

Quitclaim Deed. A Quitclaim Deed differs from a Warranty Deed in that it merely transfers whatever interest the grantor has in the property. It contains no covenants and makes no promises of defense of title. This is the type of deed that confidence men sometimes use in selling buildings or lands which they do not own. They transfer only their professed interest. If the title is good, however, a Quitclaim Deed will give the grantee full right to the property.

Joint Tenancy. If the purchaser is married, consideration should be given to the manner in which the real estate is to be held. When two or more persons hold real estate, it may be held as: (1) *Joint tenants and not as tenants in common* or (2) as *tenants in common.*

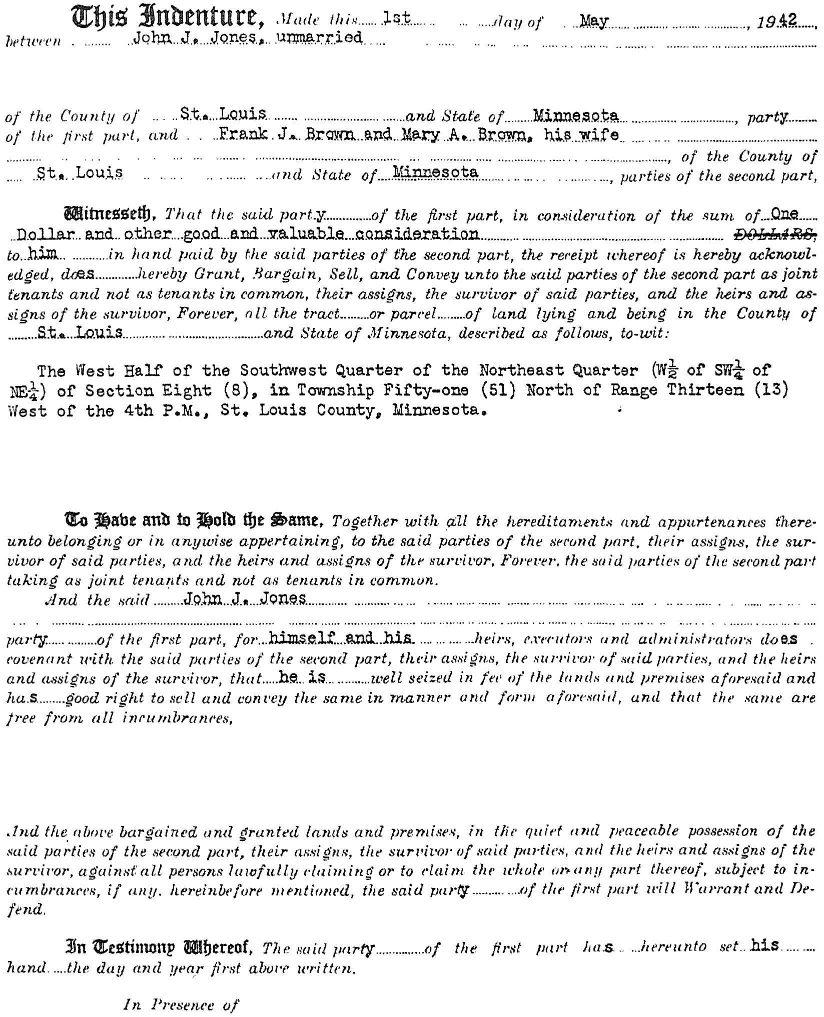
Under Joint Tenancy ownership, when one of the owners dies, the survivor or survivors receive full title without the necessity of probate court proceedings. In some states the filing of a certified copy of the death certificate with the proper office in the county where the land is situated clears the title, so that it will appear in the name of the survivor or survivors. In most cases this is a desirable plan of ownership between husband and wife, particularly when the land owned is used as the seat of their home. Since the law covering joint tenancy may differ from state to state, however, it is suggested that the law of your state be examined to determine whether or not this form of deed will convey the advantages pointed out above. When real estate is held in Joint Tenancy, either one of the parties is deprived of the right to dispose of the property through a will. For example, if John Jones and William Jones, brothers, own property in joint tenancy, and John should make a will transferring his interest in the property to his sister, upon his death that interest would pass to his brother regardless of the will, and in that event his heirs would have no interest in the real estate.

Tenants in Common. Under this type of plural ownership each co-owner has an undivided interest in the land in proportion to his holdings. Each party may sell his or her interest at any time, and may dispose of that interest through a will. In the event of death without leaving a will, the interest of the deceased would pass to his heirs as provided by law. Where two or more persons hold real estate in this manner they will share in the income in proportion to the interest held by them. Where strangers own property together, this is the proper type of deed.

EXECUTION OF THE DEED

When a deed is prepared in accordance with the wish of

EXHIBIT E. WARRANTY DEED TO JOINT TENANTS



This Indenture, *Made this* 1st *day of* May, 1942, *between* John J. Jones, unmarried

of the County of St. Louis *and State of* Minnesota, *party of the first part, and* Frank J. Brown and Mary A. Brown, his wife, *of the County of* St. Louis *and State of* Minnesota, *parties of the second part,*

Witnesseth, *That the said party of the first part, in consideration of the sum of* One Dollar and other good and valuable consideration ~~DOLLARS,~~ *to* him *in hand paid by the said parties of the second part, the receipt whereof is hereby acknowledged,* does *hereby Grant, Bargain, Sell, and Convey unto the said parties of the second part as joint tenants and not as tenants in common, their assigns, the survivor of said parties, and the heirs and assigns of the survivor, Forever, all the tract or parcel of land lying and being in the County of* St. Louis *and State of Minnesota, described as follows, to-wit:*

The West Half of the Southwest Quarter of the Northeast Quarter (W½ of SW¼ of NE¼) of Section Eight (8), in Township Fifty-one (51) North of Range Thirteen (13) West of the 4th P.M., St. Louis County, Minnesota.

To Have and to Hold the Same, *Together with all the hereditaments and appurtenances thereunto belonging or in anywise appertaining, to the said parties of the second part, their assigns, the survivor of said parties, and the heirs and assigns of the survivor, Forever, the said parties of the second part taking as joint tenants and not as tenants in common.*

And the said John J. Jones *party of the first part, for* himself and his *heirs, executors and administrators* does *covenant with the said parties of the second part, their assigns, the survivor of said parties, and the heirs and assigns of the survivor, that* he is *well seized in fee of the lands and premises aforesaid and* has *good right to sell and convey the same in manner and form aforesaid, and that the same are free from all incumbrances,*

And the above bargained and granted lands and premises, in the quiet and peaceable possession of the said parties of the second part, their assigns, the survivor of said parties, and the heirs and assigns of the survivor, against all persons lawfully claiming or to claim the whole or any part thereof, subject to incumbrances, if any, hereinbefore mentioned, the said party of the first part will Warrant and Defend.

In Testimony Whereof, *The said party of the first part* has *hereunto set* his *hand the day and year first above written.*

In Presence of

the parties to the transaction, it must be signed by the grantor and acknowledged before some proper officer—usually a notary public—whose certificate of acknowledgment is added to the instrument. In some states two subscribing witnesses are required. The grantor, in order to make the deed effective, must deliver it to the grantee, since this act transfers title. The delivery of the deed may be made through agents of the parties. As a rule, if the grantor is married, his wife must join in signing the deed, otherwise she will retain her dower interest in the land. There are a few states that do not require the wife's signature, except in case of sale of the homestead. If he is unmarried, the deed should show the fact, as for example, John Jones, unmarried, or single, or bachelor. When documentary stamps are required, they should be placed on the deed before filing. The seller is usually required to pay the cost for these stamps. At this point, the deed should be checked carefully to make sure that the property is accurately described, and that the grantor's name is correctly spelled and is written as it appears in the abstract of title.

RECORDING THE DEED

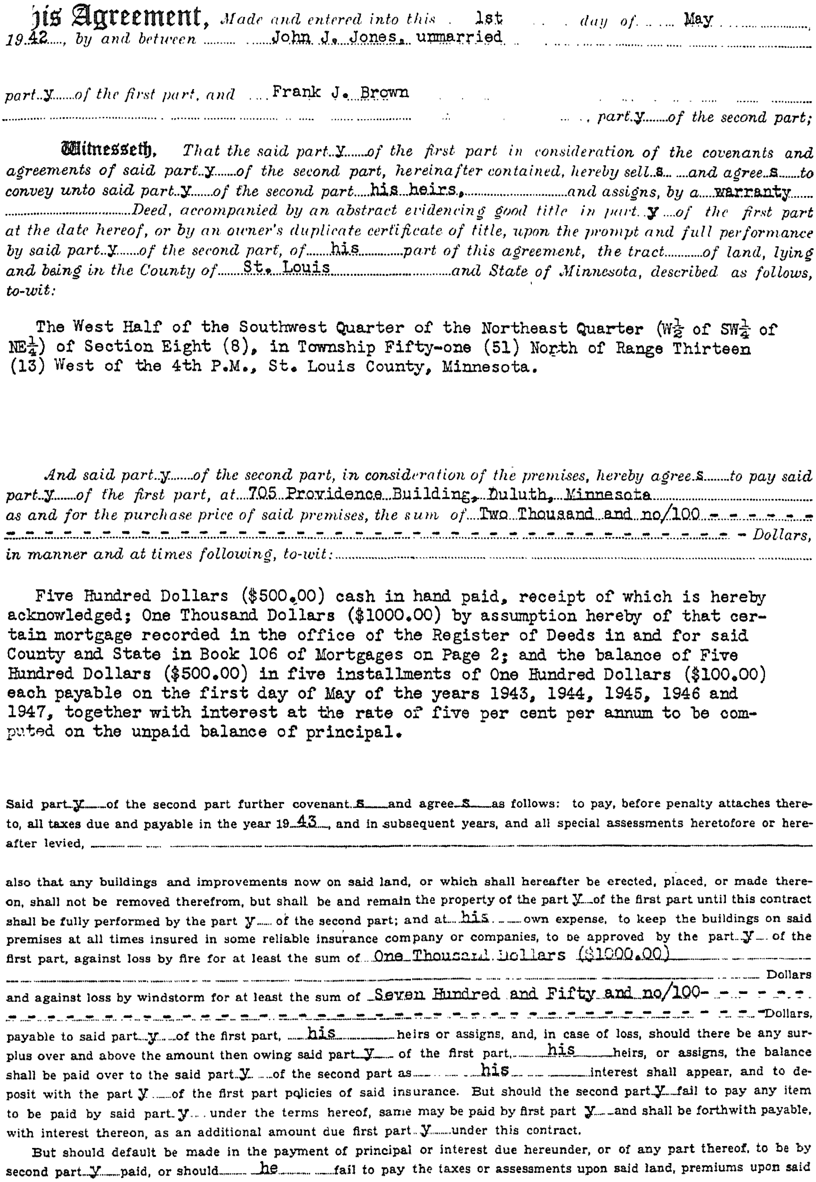
It is wise to record the deed immediately after it is executed. It should be taken to the office of record in the County where the land is situated and the officer in charge should be requested to place it on record. A small fee is collected for performing this service. The filing and recording of the deed gives notice to the public of the grantee's interest in the land. If one fails to record the deed, and is not living on the land, someone else may take a deed on the same land, claiming that he had no evidence of your rights. In that event, if the second deed was filed and recorded before yours, the grantee under the second deed would have a superior title, assuming that he had no actual notice of your rights in the land.

CONTRACT FOR DEED

In some instances, where the purchaser of a farm is able to make only a small down payment on the purchase price, the seller gives a Contract for Deed instead of an outright deed to the land. The contract specifies the terms that must be met before a formal deed is executed and delivered by the seller conveying full title to the property. Usually, 25% to 40% of the purchase price must be paid before title is transferred, though the amount is a matter of bargaining between the parties concerned. Exhibit F illustrates the form of a Contract for Deed.

Under this type of ownership, failure to comply with the terms of the contract will permit the seller to foreclose the buyer's interest by canceling the contract. In most states the manner

EXHIBIT F. CONTRACT FOR DEED



his Agreement, *Made and entered into this* 1st *day of* May, *19*42, *by and between* John J. Jones, unmarried

*part*y *of the first part, and* Frank J. Brown *part*y *of the second part;*

Witnesseth, *That the said part*y *of the first part in consideration of the covenants and agreements of said part*y *of the second part, hereinafter contained, hereby sell*s *and agree*s *to convey unto said part*y *of the second part* his heirs, *and assigns, by a* warranty *Deed, accompanied by an abstract evidencing good title in part*y *of the first part at the date hereof, or by an owner's duplicate certificate of title, upon the prompt and full performance by said part*y *of the second part, of* his *part of this agreement, the tract of land, lying and being in the County of* St. Louis *and State of Minnesota, described as follows, to-wit:*

The West Half of the Southwest Quarter of the Northeast Quarter ($W\frac{1}{2}$ of $SW\frac{1}{4}$ of $NE\frac{1}{4}$) of Section Eight (8), in Township Fifty-one (51) North of Range Thirteen (13) West of the 4th P.M., St. Louis County, Minnesota.

*And said part*y *of the second part, in consideration of the premises, hereby agree*s *to pay said part*y *of the first part, at* 705 Providence Building, Duluth, Minnesota *as and for the purchase price of said premises, the sum of* Two Thousand and no/100 - *Dollars, in manner and at times following, to-wit:*

Five Hundred Dollars ($500.00) cash in hand paid, receipt of which is hereby acknowledged; One Thousand Dollars ($1000.00) by assumption hereby of that certain mortgage recorded in the office of the Register of Deeds in and for said County and State in Book 106 of Mortgages on Page 2; and the balance of Five Hundred Dollars ($500.00) in five installments of One Hundred Dollars ($100.00) each payable on the first day of May of the years 1943, 1944, 1945, 1946 and 1947, together with interest at the rate of five per cent per annum to be computed on the unpaid balance of principal.

Said party of the second part further covenants and agrees as follows: to pay, before penalty attaches thereto, all taxes due and payable in the year 1943, and in subsequent years, and all special assessments heretofore or hereafter levied,

also that any buildings and improvements now on said land, or which shall hereafter be erected, placed, or made thereon, shall not be removed therefrom, but shall be and remain the property of the party of the first part until this contract shall be fully performed by the party of the second part; and at his own expense, to keep the buildings on said premises at all times insured in some reliable insurance company or companies, to be approved by the party of the first part, against loss by fire for at least the sum of One Thousand Dollars ($1000.00) Dollars and against loss by windstorm for at least the sum of Seven Hundred and Fifty and no/100- Dollars, payable to said party of the first part, his heirs or assigns, and, in case of loss, should there be any surplus over and above the amount then owing said party of the first part, his heirs, or assigns, the balance shall be paid over to the said party of the second part as his interest shall appear, and to deposit with the party of the first part policies of said insurance. But should the second party fail to pay any item to be paid by said party under the terms hereof, same may be paid by first party and shall be forthwith payable, with interest thereon, as an additional amount due first party under this contract.

But should default be made in the payment of principal or interest due hereunder, or of any part thereof, to be by second party paid, or should he fail to pay the taxes or assessments upon said land, premiums upon said

(Continued on next page)

of canceling land contracts is prescribed by statute. Proceedings of this type require strict compliance with such laws. It is well

EXHIBIT F. CONTRACT FOR DEED—Continued

insurance, or to perform any or either of the covenants, agreements, terms or conditions herein contained, to be by said second part...... kept or performed, the said party of the first part may, at his option, by written notice declare this contract cancelled and terminated, and all rights, title and interest acquired thereunder by said second part...... shall thereupon cease and terminate, and all improvements made upon the premises, and all payments made hereunder shall belong to said party of the first part as liquidated damages for breach of this contract by said second party, said notice to be in accordance with the statute in such case made and provided.

Neither the extension of the time of payment of any sum or sums of money to be paid hereunder, nor any waiver by the party of the first part of his rights to declare this contract forfeited by reason of any breach thereof, shall in any manner affect the right of said party to cancel this contract because of defaults subsequently maturing, and no extension of time shall be valid unless evidenced by duly signed instrument. Further, after service of notice and failure to remove, within the period allowed by law, the default therein specified, said party of the second part hereby specifically agreeS...... upon demand of said party of the first part, quietly and peaceably to surrender to him possession of said premises, and every part thereof, it being understood that until such default, said party of the second part is to have possession of said premises.

It is Mutually Agreed, *By and between the parties hereto, that the time of payment shall be an essential part of this contract; and that all the covenants and agreements herein contained shall run with the land and bind the heirs, executors, administrators, successors and assigns of the respective parties hereto.*

In Testimony Whereof, *The parties hereto have hereunto set their hands the day and year first above written.*

In Presence of

State of Minnesota, } ss.
County of St. Louis }

On this 1st *day of* May, *19*42, *before me,*
a Notary Public *within and for said County, personally appeared*
John J. Jones, unmarried and Frank J. Brown

*to me known to be the person*s *described in, and who executed the foregoing instrument, and acknowledged that* they *executed the same as* their *free act and deed.*

Notary Public St. Louis *County, Minn.*

My commission expires February 6th, *19*46.

for one accepting a contract for deed to read the laws of the state in which the contract is offered, so as to be fully familiar with its application. Usually, under a cancellation proceeding in case of failure to meet the terms of the contract, the seller can gain possession of the land within a comparatively short time. For this reason, purchasing real estate under contract requires that the buyer meet the stipulated payments promptly and that he perform all other provisions of the contract. Failure to do so will give the seller the right to cancel the contract. The purchaser under a Contract for Deed is usually required to pay the taxes and to keep the buildings on the premises properly insured.

MORTGAGES

A mortgage is the written conveyance of the title to property as security for the payment of a debt or other obligation. The person making the mortgage, such as an owner of the land borrowing money, is the mortgagor; the party loaning the money is called the mortgagee. More than one mortgage may be made on a given parcel of land, in which case they may be referred to as first and second mortgages. Promissory notes are usually executed in addition to the mortgage and, in good practice, reference is made to the note or notes to the effect that they are secured by a certain mortgage.

The mortgage, in addition to other provisions, contains covenants similar to those appearing in a Warranty Deed. The conveying provisions, however, become null and void when all the terms of the mortgage are fulfilled.

As shown above in the Contract for Deed, a mortgage may already be an encumbrance on the land when bought. In that case, the purchaser in purchasing the farm may receive a deed and assume the contract obligation of the mortgage. If the mortgagor fails to meet the payments or other conditions of the mortgage, the mortgagee may foreclose the mortgage as provided by the statutes of the state where the land is situated. Usually, under a mortgage foreclosure the mortgagor has a period of time, usually one year, within which he may redeem the property. In some cases under the moratorium in force in some states this period may be prolonged.

Points to Be Remembered in Buying a Farm

1. Make a complete inspection of the farm.
2. Be sure that the boundaries are properly defined, so that there will be no party line dispute.
3. Secure the services of a reputable lawyer.
4. Assure yourself that the seller has good title.
5. Draw the Earnest-Money Contract with care.
6. Read and examine the deed or contract for deed carefully and see that it is properly executed and is of the correct type.
7. If the seller is married, have his wife join with him in the deed.
8. Check for mechanics' liens and also ascertain the interest of parties in possession.
9. Make certain that all documents are recorded immediately in the proper office.
10. Do not rely on verbal representation, when such representations can be reduced to writing and signed by the parties.

FARM LEASE CONTRACTS

Recent figures show that 39 per cent of the farms in the United States are operated by renters. In each case, these transactions involve a lease either written, verbal, or implied. Frequently the arrangements entered into between the owner and the renter are of a loose and indefinite character, resulting in misunderstandings throughout the term of the lease. This lack of more careful attention contributes largely to unsatisfactory relationships between landlord and tenant. While laws covering this subject may clarify certain practices and procedures, the real improvement must come through the owner's and the renter's "talking things over." The best time to carry on these conversations is *before* entering into the leasing agreement. The points agreed upon should then be written into a valid lease. A written lease properly drawn, with provisions thoroughly understood by the parties involved, will solve most of the problems that are likely to develop. In many cases, however, a written lease is just a matter of form. For example, the landlord obtains a form and has it filled in and signed without studying its contents or considering its suitability. This written document will be interpreted by the courts, if trouble arises, on the basis of the written provisions. In other cases, the owner may be familiar with the contents, but the renter may be wholly unaware of what the contract contains. Such cases are likely to lead to poor relationships between the parties to the lease.

Because so many leases are poorly drawn and the content of the lease so little understood, an analysis of one of the common lease forms is presented in the following section. Comments are made on each provision of the lease for the purpose of calling attention to the points over which controversies are likely to arise. The discussion will serve the further purpose of familiarizing the student with the provisions commonly printed in lease forms.

A SAMPLE FARM LEASE

THIS AGREEMENT, *Made this* *day of* *19*
by and between
party of the first part, Lessor, and
of the Township of *County of*
and State of *party of the second part, Lessee,*

WITNESSETH, That the said party of the first part, in consideration of the rents and covenants hereinafter mentioned, does hereby Remise, Lease and Let unto the said party of the second part, and the said party of the second part does hereby

hire and take from the said party of the first part, the following described premises situated in the County of and State of viz:
in Section Number Township Number Range Number
containing acres be the same more or less, of which described premises the second party hereby agrees to plow and put in crops not less than acres each year during the continuance of this Lease.

TO HAVE AND TO HOLD, *The above rented premises unto the said second party, heirs and assigns, subject to the conditions and limitations hereinafter mentioned, for and during the full term of years from and after the day of 19 , the term of this Lease ending the day of 19*

And the said second party agrees to and with the said first party to pay as rent for the above mentioned premises, for and during the full term of this Lease, the sum of Dollars, payable at in installments with interest at the rate of per cent on each installment after due, to-wit:

$ on or before $ on or before
$ on or before $ on or before
$ on or before $ on or before
$ on or before $ on or before
$ on or before $ on or before

And it is Further Agreed, By and between the parties as follows: That should the said second party fail to make the above mentioned payments as herein specified, or to pay any of the rent aforesaid when due, or fail to fulfill any of the convenants herein contained, then and in that case said first party may re-enter and take possession of the above rented premises, and hold and enjoy the same without such re-entering working a forfeiture of the rents to be paid by the said second party for the full term of this lease.

That if the said first party sells said premises during the life of this lease and before the crop is in the ground, and desires to give possession to the purchaser, that the second party will forthwith surrender possession of said leased premises upon the payment to of $ per acre for each acre of said premises newly plowed by said second party at the time said possession is demanded if sold after the crop is in, then said second party shall have the right to remove such crop when ready to be harvested. That if said first party sells said premises during the term of this lease, the purchaser may at any time enter upon the leased premises for the purpose of plowing, breaking more land, summer-fallowing, cultivating or otherwise improving any part of said premises not in actual cultivation by said second party, and without such entry working any forfeiture of the rents herein agreed to be paid.

That if said second party remains in possession of said premises after the expiration of the term for which they are hereby leased, such possession shall not be construed to be a renewal of this lease, but to be a tenancy at the will of said first party, which may be terminated upon ten days' notice, given by the said first party in writing, either delivered to second party or sent to in a sealed envelope, duly stamped and directed to at which is hereby declared by to be usual Post-office address.

And the said second party also covenants and agrees to and with the said first party, not to assign this lease or underlet the above rented premises or any part thereof, without first obtaining the written consent of the said first party.

And that will, at the expiration of the time as herein recited, quietly yield and surrender the aforesaid premises to the said first party, his heirs or assigns, in as good condition and repair as when taken, reasonable wear and tear and damage by the elements alone excepted. Said second party also covenants and agrees to cultivate the hereby leased premises in a careful and husband-like manner, and to maintain and keep up the fences so as to protect all crops from injury and waste, and to protect the fruit and shade trees thereon, and to cut no green trees and to commit no waste or damage on said real estate and to suffer none to be done; and to keep up and maintain in good repair all buildings, stables, cribs, fences and improvements on said farm; and further agrees not to remove any straw or manure from said farm, but to spread upon said premises all manure made thereon.

The party of the second part is also to destroy all Russian thistles and other noxious weeds growing on said land, declared by statute to be common nuisances, within the times prescribed by law, and shall keep all roadways and other parts of the land, not in crop, mowed and free from growing weeds. And the first party or his agent shall have the right to enter upon said premises at any time, without injury to the standing crops, for the purpose of making any improvements, or to prepare for the succeeding crop.

And the said first party covenants that the said second party, on paying the rent and performing the covenants aforesaid, shall peaceably and quietly have, hold and enjoy the said remised premises for the term aforesaid.

To secure the payment of the rents herein specified and the faithful performance and strict fulfillment of all the covenants of said second party in this lease contained, said second party does hereby expressly mortgage unto said first party all crops growing or grown on said premises during the term of this lease, and does hereby expressly authorize and fully empower said first party in the case of any default on the part of said second party in paying said rent or in performing any of the covenants in this lease, to seize and take possession of said mortgaged property at once, and sell the same at public auction, with notice as provided by law and out of the proceeds of said sale, to pay and discharge all rents, damages and expenses which may at the time be due and incurred, and pay over to said second party the surplus money arising from such sale.

IN TESTIMONY WHEREOF, *Both parties have hereunto set their hands and seals the day and year hereinbefore written, and I, the undersigned mortgagor hereby acknowledge that at the time of the making and delivery of the foregoing Chattel Mortgage the mortgagee delivered to me a full, true and complete copy thereof.*

Signed, Sealed, and Delivered
in Presence of

....*Seal*

....*Seal*

....*Seal*

....*Seal*

STATE OF......................................
} *ss.*
COUNTY OF..

On this..day of..A. D. 19 , before me a ....within and for said County, personally appeared ....

to me known to be the person described in and who executed the foregoing instrument, and acknowledged that he executed the same as..........................free act and deed.

ANALYSIS OF THE FARM LEASE *

Forms of farm lease contracts are numerous and vary greatly. They are based on the laws in force in the states where used. Because of the variation in laws from state to state and the numerous forms of lease contracts in use, it is thought best to present only one lease form with a comprehensive discussion of the provisions as stated. Instructors are advised to make collections of the forms of lease contracts in use in the school district served and to make a comparative analysis of the provisions of each.

A. "THIS AGREEMENT, made this 15th day of February, 1942, by and between John S. Brown, of St. Paul, Minnesota, party of the first part, Lessor, and Frank Jones, of Fulda, Minnesota, party of the second part, Lessee."

The relationship of landlord and tenant is created by contract, either express or implied, by the terms of which one person, designated the tenant, enters into possession of the land under another person, known as the landlord. The word landlord, under ordinary usage means the same as "lessor," and the word tenant, the same as "lessee." It is well to remember the meanings of these terms.

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* The form of lease presented is only one of many forms found in common use. It is discussed in sections to acquaint the student with the many complex problems covered in a lease. Leases for cash rent, cash and crop-share leases, crop and livestock-share leases are used in many varying forms. While each form is carefully and skillfully drawn, it must be studied with care before adapting it to specific use in leasing a farm.

A lease has been defined as a contract for the possession and profit of land on the one side, and a recompense of rent, or other income, on the other. As in the case of all contracts, there must be two or more parties competent in the eyes of law to transact business. The words, "party of the first part," and "party of the second part" are used for the purpose of making certain the identification of the parties relative to their respective undertakings and to eliminate the necessity of repeating their names in full each time. Much humor is attached to these phrases by the public, but, nevertheless, they serve a real purpose. The important phase of this section of a lease contract is to make sure that the persons making it have the right and the power to make the lease and to be bound by all its provisions.

B. "WITNESSETH, That the said party of the first part, in consideration of the rents and covenants hereinafter mentioned, does hereby Remise, Lease, and Let unto the said party of the second party, and the said party of the second part does hereby hire and take from the said party of the first part, the following described premises situated in the County of................................and State of.............................viz.: "in Section Number..................................Township Number..................................Range Number..................................containing ....acres be the same more or less, of which described premises."

The word "remise" means to convey or to grant; the word "lease," to grant possession of lands for a period, and the word "let," to permit the use of the land.

A lease is a conveyance, although it conveys a lesser interest than that held by the owner, or landlord. No particular form of words is necessary to constitute an instrument a lease and to create the relationship of landlord and tenant. At Common Law, the unwritten law, an oral lease is valid. In most jurisdictions, there are, however, statutes relating to the execution of conveyances of interest in land, or statutes of fraud which require a writing signed by the lessor where the lease is of a certain duration. For example, in Minnesota, any lease running for a period of more than one year from the time of its making, must be in writing. This requirement may differ in the various states. The safe and best rule to follow is to have a written lease without regard to the length of the same. In this section of the lease, the description of the property is shown and this description must be complete in all respects. The premises *must* be described with certainty.

C. "The second party hereby agrees to plow and put in crops not less than............ acres each year during the continance of this lease."

In all cases the courts will give a liberal interpretation of this provision of a lease, since weather and the elements sometimes may require modification of the farming operations and hence strict compliance would be impossible. In many lease forms, however, the landlord exercises a more complete control than is shown in the above provision, in which case the tenant is obligated to carry out his part of the agreement. Remember, the tenant has possession of valuable property and, without some restrictions on its use, the tenant could, unless stated, make any use of the land short of waste. For that reason a careful landlord will set out in a lease the definite specifications relative to the use to be made of the land.

D. "TO HAVE and TO HOLD, The above rented premises unto the said second party,........................heirs and assigns, subject to the conditions and limitations hereinafter mentioned, for and during the full term of........................years from and after the........................day of.., 19........, the term of this lease ending the........................day of.., 19........."

This provision gives the tenant the right to quiet and peaceful enjoyment and use of the land for a definite period of time. At the end of this period, the tenant is obligated, under his agreement, to return the land to the owner. In a provision that follows, this point will be discussed more fully, as may be noted from the language, "subject to the conditions and limitations hereinafter mentioned."

It should be observed that, in the absence of a provision so permitting, a landlord may not enter the premises during the term of the lease. Although there is authority to the effect that a landlord has the right during a tenancy to enter to make such repairs as are necessary to prevent waste; yet, unless the landlord reserves the right, he has, during the term of the lease, no right to enter upon the demised premises to make alterations and improvements, to investigate the need of repairs, or to make even necessary repairs. His presence on the property would be that of a trespasser, and subject to ejectment from the premises. It may be seen from this observation that leasing a farm is a serious business from the viewpoint of the landlord as well as from that of the tenant.

Under some lease forms a provision is added to the effect that this lease shall continue for a like term unless written notice is given to the landlord thirty days prior to date of termination. Under provision of this type, a tenant or a landlord will be bound to continue, renew, or extend the lease for a like period unless the proper notice is given. The notice should be in writing and sent by registered mail with a return receipt requested, so that no question as to compliance can be raised. The notice should be mailed early, so as to avoid technicalities regarding the 30-day requirement. This form of provision can be a double-edged sword. It may work as an advantage or a disadvantage to either party. For example, if, as a tenant, you fail to read the provision and rent another farm without giving notice, you may find yourself bound to pay rent on two farms. Some courts hold that the word "extends" means the present lease is in effect for another term, whereas the word "renew" requires the preparation and execution of a new lease under the same terms.

E. "And the said second party agrees to and with the said first party to pay as rent for the above mentioned premises, for and during the full term of this Lease, the sum of..Dollars, payable to.. in............installments with interest at the rate of...............per cent on each installment after due, to-wit:

$......................on or before........................ $....................on or before........................
$......................on or before........................ $....................on or before........................
$......................on or before........................ $....................on or before........................
$......................on or before........................ $....................on or before........................
$......................on or before........................ $....................on or before......................"

In this section of the lease, the amount of rent charged and the manner of payment should be set out in full. The landlord has a right to expect that the payment will be made promptly and in accordance with the terms of the agreement. In order to protect against a default in payment, the landlord and tenant should arrange that the payments shall be placed at times when the tenant will be in position to meet them from the profits of the farming operation. If the land is operated as a dairy farm, monthly installments may be the better plan of payment. If the tenant derives his profit exclusively from corn as a cash crop, then payment late in the fall, in one installment, may be the most desirable plan. The point emphasized here is to arrange payment at a suitable time when the tenant is likely to be in position to carry out the agreement.

F. "And it is further agreed, By and between the parties as follows: That should the said second party fail to make the above mentioned payments as herein specified, or to pay any of the rent aforesaid when due, or fail to fulfill any of the *covenants herein contained, then and in that case said first party may re-enter and take possession of the above premises, and hold and enjoy the same without such re-entering working a forfeiture of the rents to be paid by the second party for the full term of the lease."*

The rights of the landlord upon default of the tenant are expressed in this provision. Failure to make payment as agreed will permit the landlord to take possession and at the same time hold the tenant liable for the balance of the rent. While the decisions of the court may vary in giving full force to the intent of this provision, yet a safe rule is to be prepared to make all payments promptly, or "talk it over" with the landlord.

G. "That, if the said first party sells said premises during the life of this lease and before the crop is in the ground, and desires to give possession to the purchaser, the second party will forthwith surrender possession of said leased premises upon the payment to..of $..per acre for each acre of said premises newly plowed by said second party at the time said possession is demanded. If sold after the crop is in, then said second party shall have the right to remove such crop when ready to be harvested. That if said first party sells said premises during the term of this lease, the purchaser may at any time enter upon the leased premises for the purpose of plowing, breaking more land, summer-fallowing, cultivating or otherwise improving any part of said premises not in actual cultivation by said second party, and without such entry working any forfeiture of the rents herein agreed to be paid."

The above provision, known as the sales clause, appears in many lease forms. This in effect renders the term of lease uncertain. For example, a five-year lease containing a like provision could be terminated during any year of the term by a sale of the property and the proper notice. This type of provision is one of the main problems under our system of land tenure. A tenant whose term is uncertain is little inclined to make improvement in buildings or land operations since he does not know whether or not he can benefit by such improvement. This practice puts a damper on long-time planning and in the end both the landlord and the tenant suffer. Public opinion favors a modification of this practice by requiring the landlord to pay the tenant for any unused portion of improvements made by him upon surrendering possession to the landlord for any reason. An example of this provision might be where the tenant applies lime on alfalfa. The beneficial result of this application may well carry over beyond the term of the lease. Or it may be a case of seeding alfalfa, applying fertilizers, or summer fallowing of the land. Students of this problem realize that any action which would restrict or interfere with the sale of land would hinder, to some degree, the possibility of converting absentee landlord-owned farms to owner operated farms; and that any provision permitting the sale without full regard for the interests of the tenant may bring about exploitation of the soil, without long range conservation. It is not too much to hope that a compromise between these extremes may be worked out through proper compensation to the tenant for his disturbance from possession. This should include cost of moving as well as cost of the improvement made. The compensation or reimbursement can be determined by the parties or through an arbitration board selected in a manner provided by agreement.[*]

This provision is sometimes used in settling differences under a stock-share lease, where adjustments in livestock increase and inventories of feed supplies are necessary upon termination of the lease.

H. "That, if said second party remains in possession of said premises after the expiration of the term for which they are hereby leased, such possession shall not be construed to be a renewal of this lease, but to be a tenancy at the will of the said first party, which may be terminated upon ten days' notice, given by the said first party in writing, either delivered to second party or sent to.. in a sealed envelope, duly stamped and directed to.. at..which is hereby declared by... to be..............................usual post office address."

Under the above provision, the lease definitely expires on a certain date. If a tenant should hold over beyond the term, the landlord has the advantage of considering the occupant as a tenant for a year, or he may treat him as a tenant at will. Under the latter arrangement, the tenancy is uncertain insofar as the renter is concerned; but, if the landlord permits the tenant to put in a crop without attempting to remove him, most courts would hold that a lease was implied from the acts of the parties. Implied leases of this type are unsatisfactory from the viewpoint of both parties. No person should bargain for a lawsuit when "talking things over" may produce favorable results and save worry, time, and expense.

I. "And the said second party also covenants and agrees to and with the said first party, not to assign this lease or underlet the above rented premises or any part thereof, without first obtaining the written consent of the said first party."

Ordinarily a tenant may assign or sublet his lease to another unless the landlord limits that right. For that reason most leases contain a restriction somewhat as stated above. This provision requires the written consent of the landlord and, therefore, before a tenant could assign or sublet under the lease, he would be required to discuss the matter with the landlord and secure his written consent. Otherwise, failure to do so would be considered a breach of contract. This rule also applies to subletting a portion of the farm.

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[*] "All disputes and differences arising out of this lease shall be settled and finally determined in the City of...................., by arbitration in the following manner. Each party to this agreement shall appoint an arbitrator. If the two arbitrators so appointed can not agree within one month after their appointment, they will select a third arbitrator. The decision of the three arbitrators, or any two of them, shall be final and binding upon the parties herein, who shall conform to and abide by said decision. If either party fails to appoint his arbitrator within fourteen days after notice in writing requires him to do so, the arbitrator appointed by the other party shall act for both; his decision in writing shall be final and binding upon both parties, as if he had been appointed by counsel, and both parties thereto shall conform to and comply therewith."

J. "and that..will, at the expiration of the time as herein recited, quietly yield and surrender the aforesaid premises to the said first party, his heirs or assigns, in as good condition and repair as when taken, reasonable wear and tear and damage by the elements alone excepted. Said second party also covenants and agrees to cultivate the hereby leased premises in a careful and husbandlike manner, and to maintain and keep up the fences so as to protect all crops from injury and waste, and to protect the fruit and shade trees thereon, and to cut no green trees and to commit no waste or damage on said real estate and to suffer none to be done; and to keep up and maintain in good repair all buildings, stables, cribs, fences and improvements on said farm; and further agrees not to remove any straw or manure from said farm, but to spread upon said premises all manure made thereon."

Under this section of the lease, the tenant agrees to return the premises in as good a condition as when he received them, reasonable wear and tear excepted. It will be noted that the landlord does not obligate himself to make repairs. The landlord is under no obligation to make repairs or improvements unless he has expressly agreed to do so, and there is no implied covenant in a lease that the premises are or will continue to be fit for the purpose for which they are let. In order to exclude any claim that the landlord has made an agreement to repair, some leases state specifically that the landlord is under no obligation to make any repairs or improvement and that the tenant takes the premises as they are.

Also, a landlord, unless he has agreed to do so, is not ordinarily bound to furnish water to his tenant.

While the tenant is prevented from cutting green trees under this provision, it would seem clear that the rule generally followed in this country is that the tenant has the right to take from the demised premises such an amount of wood or lumber as is required or necessary for fuel, the repair of buildings, the repair of implements of husbandry, the repair of fences, and other agricultural needs.

The rule regarding disposition of manure created on the land indicates that, where the feed is grown on the premises, such manure must be returned to the land; but, where a tenant purchases hay, straw and feed, or where he produces such feed on another tract of land, that such portion may be removed without violation of the provision, unless a specific provision prevents such disposition.

K. "The party of the second part is also to destroy all Russian thistles and other noxious weeds growing on said land, declared by statute to be common nuisances, within the times prescribed by law, and shall keep all roadways and other parts of the land, not in crop, mowed and free from growing weeds. And the first party or his agent shall have the right to enter upon said premises at any time, without injury to the standing crops, for the purpose of making any improvements or to prepare for the succeeding crop."

The provision relative to the treatment of weeds is common and, in any event, most states have laws governing the control of noxious weeds. The tenant is obligated to comply with this provision as well as with the State Laws.

L. "And the said first party covenants that the said second party, on paying the rent and performing the covenants aforesaid, shall peaceably and quietly have, hold, and enjoy the said remised premises for the term aforesaid."

After performing all these conditions, the tenant has the exclusive right of quiet and peaceable enjoyment of the entire premises.

M. "To secure the payment of the rents herein specified and the faithful performance and strict fulfillment of all the covenants of said second party in this lease contained, said second party does hereby expressly mortgage unto said first party all crops growing or grown on said premises during the term of this lease, and does hereby expressly authorize and fully empower said first party, in the case of any default on the part of said second party in paying said rent or in performing any of the covenants in this lease, to seize and take possession of said mortgaged property at once, and sell the same at public auction, with notice as provided by law and out of the proceeds of said sale to pay and discharge all rents, damages, and expenses which may at the time be due and incurred, and pay over to said second party the surplus money arising from such sale."

The provision known as a Chattel Mortgage clause conveys the title and right to possession of the crops grown on the premises as security for the payment of the rent stipulated in the lease. Some provisions go so far as to include all the personal property owned by the tenant. No particular words or phrases are necessary to create a mortgage as long as the intent of the parties is present. Most states, however, require a lease with a chattel mortgage clause to be executed before a notary and properly witnessed in order that it may be filed in the proper recording office. The filing of the instrument gives third parties notice of the existence of the mortgage.

Usually a lease form will provide adequate space to insert special provisions. The arbitration clause heretofore shown may be treated as a special provision. Also, if a tenant, while in possession, is to, or does, install any fixtures which may later be claimed by the landlord as part of the real estate, then a provision may be made permitting the removal of such fixtures at the termination of the lease. Here would be a proper place to describe and set out any repairs or improvements that a landlord may agree to make. In view of the rule that a landlord is not obligated to make repairs unless he agrees to do so, a statement of the repairs to be made should be described in detail.

N. "IN TESTIMONY WHEREOF, Both parties have hereunto set their hands and seals the day and year hereinbefore written, and I, the undersigned mortgagor hereby acknowledge that at the time of the making and delivery of the foregoing Chattel Mortgage the mortgagee delivered to me a full, true and complete copy thereof.

Signed, Sealed, and Delivered
in Presence of

..........................Seal

..........................Seal

..........................Seal

..........................Seal

STATE OF...................
} ss.
COUNTY OF.

On this............day of....................A. D. 19....,
before me a.......................within and for said County,
personally appeared..
....
to me known to be the person.. described in and who executed the foregoing instrument, and acknowledged that he executed the same as............free act and deed.

A signed lease is binding between the parties even though such lease is not acknowledged before a Notary. In some states, however, a lease for a period of more than three years must be signed before a Notary and properly witnessed. Also, in those cases where the lease contains a Chattel Mortgage clause, the lease must be acknowledged as stated above.

Points to Observe in Renting a Farm

1. Select a good farm.
2. Discuss fully all points relative to the rental arrangement.
3. Have a written lease drawn up expressing the intention of both parties.
4. Read each provision carefully.
5. Check for Sales Clause and Chattel Mortgage Clause.
6. Have lease properly executed by the parties, making certain that the person with whom you are dealing has the power to deliver a valid lease.

NEGOTIABLE INSTRUMENTS

The farmer, to be successful, should have knowledge of business as well as of the technique of farming. The business phase of farming requires an intimate knowledge of the function of promissory notes, checks, chattel mortgages, conditional sales contracts, and bookkeeping. In this limited space it will be impossible to cover these topics fully. Emphasis will be placed on the subject of negotiable instruments, since these instruments are used to a large extent by farmers.

Notes and Checks. Promissory notes and bank checks are negotiable instruments. The former are promises to pay; the latter, orders to pay. The party signing the note and promising to pay is called the "maker," the party signing the check is called the "drawer." The party to whom these instruments are addressed is called "payee" or "drawee," respectively.

There are two important characteristics in this type of paper, which is in effect a contract. First, every negotiable instrument is presumed to have been given for a valuable consideration; secondly, such paper, like money, may be transferred from person to person. Let us examine a copy of a Promissory Note and analyze the qualities that make it negotiable.

$500.00 St. Paul, Minnesota, November 1, 1936
Six months after date I promise to pay to the order of
John Jones - - - - - - - - - - - - - - - - - -
Five hundred and no/100 Dollars
Payable at St. Paul, Minnesota.
Value received with interest at the rate of 6% per annum until paid.
William H. Peters

Figure 7. A negotiable promissory note.

Either a note or a check, to be negotiable must conform to the following requirements:

1. It must be in writing and signed by the maker, or drawer.
2. Must contain an unconditional promise or order to pay a certain sum in money.
3. Must be payable on demand or at a fixed or determinable future time.
4. Must be payable to either order or to bearer.
5. Where the instrument is addressed to a drawee, he must be named or otherwise indicated therein with reasonable certainty.

A legal instrument, to be negotiable, must contain all the essential points outlined above. If a note meets all these requirements, it may be transferred from person to person by endorsement. For example, Peters signs the above note. If Jones sells the note to Brown, he must first endorse it. If the note is transferred before it is due, Brown may collect the note, even though Peters could set up a defense against payment to Jones. That is one of the qualities of a negotiable instrument that is not common to an ordinary contract. The next illustration will bring out this point more clearly.

$100.00 St. Paul, Minnesota, December 1, 1936
Six months after date I promise to pay..................
to John Jones..
One hundred and no/100..........................Dollars
at St. Paul, Minnesota.
Value received.
William H. Peters

Figure 8. A nonnegotiable promissory note.

This note does not meet the requirement under item 4 that it—"must be payable to order or to bearer." The note states, "six months after date I promise to pay to John Jones," not "to the order of John Jones." This note, therefore, is nonnegotiable. It does not mean that the note is not good. It does mean that the original party can transfer no greater right than he has in the instrument. If Jones, the original holder, could not lawfully collect from Peters because of some defense against payment, then anyone to whom he assigned it would have no greater right to collect. Knowledge of this type of note can be helpful in some transactions. For example, if one purchased a horse on representations of the seller, and could not determine whether the representations are true, because, if misrepresented, he could return the horse and refuse payment. If one entered into a transaction where the seller has agreed not to negotiate the note, the agreement can be doubly assured by striking out the word "order." There would be no injustice to the seller, since he has given assurance he will not negotiate the note.

Signing Notes As an Accommodation. It is not uncommon for a person seeking a loan to ask another to sign a note with him as additional security to the one advancing the funds. In other words, the bank or maker advancing the funds is not fully satisfied with the promise of the borrower and wishes to gain additional security by having a second party sign the note as an accommodation. The borrower, desiring assistance in making the loan, is likely to say "I will pay this obligation when it is due and you will not be held liable." The question may well enter your mind,—What are my responsibilities if I sign this note? The answer is that an accommodation party is one who has signed the instrument as a maker without receiving value therefor, and for the purpose of lending the value of his name to some other person. Such a person is liable to a holder of the instrument for full value notwithstanding the fact that such holder at the time of taking the instrument knew him to be signing only as accommodation to the borrower. When a friend asks you to sign a note with him, it would be well to ask yourself whether, "you will be satisfied to make good the note if the other person does not pay the note when due?" If your answer is yes, then sign. It is poor policy, however, to sign notes with others.

Checking Accounts. A checking account with a bank is a convenience in paying bills or other obligations. The canceled check is evidence of payment and makes an excellent record for business purposes. As pointed out before, checks are negotiable instruments. They are orders drawn on a bank where you have an account, requesting payment. A properly drawn check is illustrated in Figure 9.

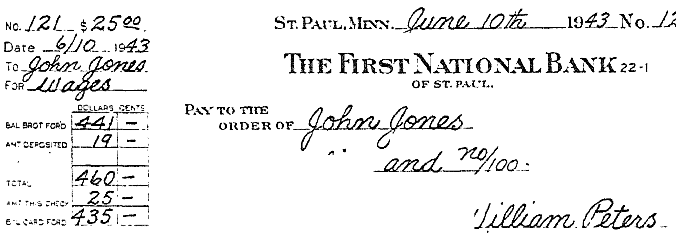
Remember that

1. Checks should be written legibly with ink or indelible pencil.
2. The date should be stated (although an undated check is not so defective as to render it nonnegotiable.
3. The name of the payee should be filled in.
4. The amount of the check shown in figures should be close to the dollar sign, so as to eliminate possibility of alteration.
5. The amount should be written out in words by starting close to the left side margin and any blank spaces filled by drawing a line to the word "Dollars."
6. The check should be signed in the manner appearing on your signature card at the bank.
7. The stub should be completed in all respects. As a matter of good practice, the stub should be filled in completely before writing the check.

You should

1. Check your balances regularly, to avoid overdrawing your account.
2. Examine carefully your monthly statement and reconcile canceled checks with entries on the stubs.
3. Retain all canceled checks for at least ten years.

The check shown in Figure 10 is payable to bearer. The word "cash" means to pay to anyone holding the check. Outside of cashing a check at a bank, checks should not be made payable to cash, since, if lost, anyone finding the check could cash it. Some large companies, however, will ask that checks be made payable to cash, when cash is actually paid out. The reason for this request is that it gives them a record of the nature of the transaction.



No. 121 $25 00
Date 6/10 1943
To John Jones
For Wages

	DOLLARS	CENTS
BAL BROT FORD	441	–
AMT DEPOSITED	19	–
TOTAL	460	–
AMT THIS CHECK	25	–
BAL CARD FORD	435	–

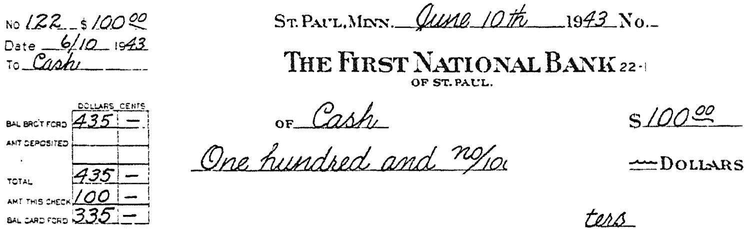
ST. PAUL, MINN. June 10th 1943 No. 121

THE FIRST NATIONAL BANK 22-1
OF ST. PAUL.

PAY TO THE ORDER OF John Jones
and no/100

William Peters

Figure 9. A nonnegotiable bank check.



No 122 $100 00
Date 6/10 1943
To Cash

	DOLLARS	CENTS
BAL BRC'T FORD	435	–
AMT DEPOSITED		
TOTAL	435	–
AMT THIS CHECK	100	–
BAL CARD FORD	335	–

ST. PAUL, MINN. June 10th 1943 No.

THE FIRST NATIONAL BANK 22-1
OF ST. PAUL.

OF Cash $100 00
One hundred and no/100 DOLLARS

ters

Figure 10. An inadvisable bank check that may be cashed by bearer.

Endorsements. Checks are usually negotiated from person to person by endorsement. The endorsement must be written on the instrument itself, or upon a paper attached thereto. The signature of the endorser without additional words is a sufficient endorsement. There are four types of endorsement as shown by the following illustrations.

The endorser of a check should remember when he accepts it that he must stand loss of the face amount of the check should the bank upon which it is drawn refuse to honor the signature of the drawee. He may get a measure of protection by signing a non recourse endorsement. See Fig. 13.

Each example represents a portion of the back of a check or note:

William Jones

Figure 11. A Blank Endorsement

A Blank Endorsement. Under this type of endorsement the instrument becomes payable to bearer.

Pay to order of
Frank Brown
William Jones

Figure 12. A Special Endorsement

A Special Endorsement. The only person eligible to transfer this instrument after delivery is Frank Brown. Use this form if you endorse a check to pay an account and you intend it to go to some particular person.

Without recourse
William Jones
or
Pay to Frank Brown
without recourse
William Jones

Figure 13. A Qualified Endorsement

A Qualified Endorsement. This type of endorsement exempts the endorser from any liability upon it; however, this does not impair the negotiability of the paper. It merely offers a measure of protection to the endorser in case of a forged endorsement or a forged signature of the maker.

Pay to Frank Brown
for collection
William Jones

Figure 14. A Restrictive Endorsement

A Restrictive Endorsement. This shows that William Jones owns the paper, and practically prohibits further negotiation, except for collection only. Another use frequently made of this type of endorsement is "Pay to the First National Bank for deposit only."—William Jones.

William Jones
Frank Brown
Pay to order of J. J. May
Frank Brown
J. J. May
Mary Carlson
etc.

A Multiple Endorsement. Negotiable instruments may be endorsed many times as indicated in the example.

Figure 15. A Multiple Endorsement

ALTERATIONS. "Where a negotiable instrument is materially altered without the assent of all parties liable thereon, it is void, except as against a party who has, himself, made, authorized or assented to the alteration and subsequent endorsers."

What constitutes a material alteration?

Any alteration which changes:

1. *The date.*
2. *The sum payable, either principal or interest.*
3. *The time or place of payment.*
4. *The number or the relations of the parties.*
5. *The medium or currency in which payment is made.*

or which adds a place of payment where no place of payment is specified. Any other change or addition which alters the effect of the instrument in any respect is a material alteration.

When one makes out a check or note, or accepts such paper, one should make certain that it is properly filled in and that no alterations appear on it.

Present Checks Promptly. As will be noted from the illustration previously shown, a check is a bill of exchange drawn on a bank, payable on demand. A check must be presented for payment within a reasonable time after its issue or the drawer will be discharged from liability thereon to the extent of the loss caused by delay. While a check does not extinguish a debt until the check is paid, failure to present it within a reasonable time might seriously affect the drawer, as in the case of bank failure. The negligence of the holder of the check might by his act prevent the payment of the check and, under such circumstance, he should suffer the consequences.

The rule generally followed is to present the check for payment within the next business day. Distance from the bank, custom of the locality, and the nature of the instrument enter into the determination as to what is "a reasonable time."

Certified Checks. In certain transactions, a certified check is sometimes required. For example, if one sold either personal or real property to a stranger and accepts a check in payment, he can insure payment of the check by requiring it to be certified. The drawer would write his personal check, take it to the bank and have it certified. The bank would immediately set aside the amount of money necessary to honor the check when presented for payment and would stamp across the face of the check the words, "Certified for Payment." Certification by the bank is equivalent to acceptance.

Where the holder has the check certified, however, all endorsers are discharged from liability. In that event, if the bank became insolvent before the check was presented for payment, the holder must look to the bank for payment. If, on the other hand, the drawer had the check certified before delivery of the check and the bank failed, the drawer could be held for payment.

Cashiers' Checks. Cashiers' checks are sometimes referred to as bankers' checks. If one purchases a cashier's check, the bank makes its check payable to the party named by the purchaser. The purchaser's name, unless the instrument is addressed to him, does not appear on the check. This type of check is generally readily accepted by business houses.

Overdrafts. While a checking account is a convenient arrangement for payment of money, it is sometimes abused. Careless persons issuing checks without regard to maintaining proper bank balances may overdraw their account and have their checks returned unpaid with the notation "Nonsufficient Funds." Issuing checks in this manner is not only embarrassing but is also in violation of the law, subjecting the drawer to certain prescribed penalties. It is, therefore, important to keep an accurate record of all bank balances.

Post-Dated Checks. The practice of post-dating checks is sometimes followed, such as issuing a check today, dated a month hence. Often creditors in pressing for payment, may ask that a check dated in advance be given. In some states such a check is treated as a promissory note. If funds are not in the bank to meet the obligation at the time of presentation, the checks will be marked "NSF." If considered as a promissory note, the result would be the same as defaulting in payment on an ordinary note. In any event, the practice is not a desirable one to follow. If funds are not sufficient when due, to meet payment, it is better to give a note than a post-dated check, thus keeping the account straight and maintaining a better banking record.

INSTALLMENT BUYING OF GOODS

Installment buying is a method of purchasing goods on the deferred payment plan. It is used extensively in this country. The types of instruments usually associated with purchases made in this manner are conditional sales contracts or chattel mortgages. In purchasing a tractor under a conditional sales contract, title in the tractor does not pass to the purchaser until all the installments have been paid.

One of the disadvantages associated with purchases of this sort lies in the uncertainty of ownership. If you pay, let us say, half of the installments and are unable to pay further, the seller may retake the tractor. You are never sure of ownership until the final payment is made. The convenience to the seller in the use of this instrument lies in the fact that he has retained title and, upon default, may retake with a minimum of legal proceedings. Most states, however, allow the original purchaser a short waiting period within which time he may redeem or, upon resale, provide for repayment of any equity he may have, which, in most cases, is little or nothing.

The second disadvantage pertains to cost. Usually the seller requires a carrying charge. Often this charge is excessive from the purchaser's viewpoint. For example, five per cent on the unpaid balance will mean actually payment of approximately ten per cent, since the purchaser, if it is a monthly contract, is paying off portions of the principal sum each month while the five per cent rate is assessed at the time of entering the contract on the total unpaid balance. This high interest rate from the seller's viewpoint is justified, since such transaction involves extra office work and, in some cases, losses on certain sales made under this plan.

Chattel Mortgages. Purchasing under a chattel mortgage on this plan is in effect the same thing; but, where a chattel mortgage is given, the purchaser must first acquire title and then, under the chattel mortgage, he sells, assigns, transfers all his right title and interest in and to the property on condition that, if he carries out all the agreed undertakings, the mortgage shall be of no effect. If all the payments are made, the mortgagor regains full title; if he fails, the mortgagee may foreclose the mortgage in the manner prescribed by law and thus obtain clear title to the goods. Both plans of purchases create uncertainty in ownership, which is undesirable from the purchaser's viewpoint. Many articles of goods, however, are purchased and paid for in this manner—goods perhaps which could not otherwise be acquired. Before buying on mortgage one should answer the following questions in the affirmative:

1. Are the goods purchased necessary?
2. Will they be productive by saving time or labor and will such effort produce a profit or a means of paying for them?

Luxuries should not be purchased on the time payment plan.

Some of the points made here will be clarified by reading with care the language and content of the conditional sales contract and chattel mortgage forms used in the community. Also, the manner of filing these instruments should be inquired into, since such filing and recording give notice to all of the rights and interests of the parties.

In purchasing chattels from individuals who are not known, a careful and prudent person will check the records in the recording office to make certain there are no mortgages or liens against the goods purchased. This rule applies to the purchase of livestock, machinery, and other equipment used by the farmer.

Suggestive Questions

1. What property is included in the term Real Estate?
2. What is the difference between Real Estate and Personal Property?
3. What is the purpose of writing a Purchase-Money Contract when negotiating for a farm?
4. What should an Abstract of Title show?
5. Why is a Warranty Deed considered better than a Quit-Claim Deed in securing title to Real Estate?
6. How many types of farm lease contracts can you name?
7. What are the dangers of "Backing a Note" for a friend?
8. What are the advantages of a checking account at a bank?
9. How should a bank check be drawn?
10. What is meant by endorsing a check?

Suggestive Activities

1. Determine by inquiry how many farms in your School District are operated by tenants and how many by owners.
2. Make lists of the types of lease found in use and compare the terms.
3. If possible attend a sheriff's sale of a foreclosed farm.
4. Attend a court session where a lawsuit is in progress.
5. Check a check book record with the monthly statement of account at a bank.

CHAPTER IV

THE USE OF CAPITAL AND CREDIT IN FARMING

Farming is a business that requires a substantial amount of capital. In farming, as in other business activities, one must usually build up capital needs by a period of apprenticeship, training, and saving. A person seldom steps out of school to find a good business waiting for him in any one of the various vocations that he might prefer.

If one has decided to follow farming as a life work, it is well to lay out a program for achieving that goal. It may be necessary to change plans many times; but, nevertheless, much better progress is likely to be made if a well-thought-out plan is followed. Such a program may well start by securing as good an education in agricultural subjects as circumstances permit. This preparation should include, if possible, high-school courses in agriculture and a course in an agricultural college. This type of education is a good foundation for farming, but it will have been a near-failure unless one is inspired by it with a desire to follow school studies by continued observation and study in after years. This self-culture may be accomplished through agricultural books, periodicals, and bulletins of the State Agricultural Experiment Stations and the United States Department of Agriculture. Attendance at Extension Service meetings, Farmers' Short Courses, and other group meetings that give contact with successful farmers often stimulate improved farm practices and profits. If possible, the program should also include an immediate start on a small scale in junior school or club projects.

How Much Capital Is Needed? Capital needs will be largely influenced and determined by the region in which the enterprise is undertaken and by the type of farming in which one decides to engage. As illustrative of the amount of capital used in farming, figures are taken from the 1940 United States Census for one or more counties in each of several states. (Table VII.)

Fortunately, not all the money needed must be in hand before one starts farming. In many good agricultural counties, 40 per cent to 50 per cent of the farms are operated by tenants. Even to operate successfully as a tenant, a capital of $2,000 to $8,000 or $10,000, depending on the region chosen and the type of farming to be followed, is desirable. Is it possible for a beginner who starts with only his hands to accumulate enough money to enable him to become a successful farmer? One of the best ways to answer this question is by inquiry among farm operators who started at the bottom and who have farmed in the region in which you propose to farm. If well acquainted with a given locality, one may know several farmers in the region who are reputed to be highly successful. Consultation with them and a rough estimate of their assets will often give a fair idea of the rate of progress made and of the problems to be overcome. Another way to test the possibilities for gain is to note the size of the larger estates left by farmers in the locality in recent years. In good agricultural regions, some farmers will be found who have built farms worth $20,000 to $50,000 or who have left estates of that size. Some of these may have secured a portion of their accumulations by inheritance or marriage, but usually some individuals are found who have achieved such success by hard work and frugal living combined with capable management. If this type of individual is fortunate in having an able, sympathetic, and co-operative wife, the chances

TABLE VII—Data on Average Value of Real Estate, Implements and Livestock per Farm in Selected Counties—April 1, 1940 U. S. Census

State	County	Acres in farm	Value per Farm			
			Real estate*	Implements & Machinery†	Livestock‡	Total
Illinois	McLean	183	$23,604	$1,642	$1,205	$26,451
Indiana	Hamilton	92	9,945	917	not available	
Iowa	Story	153	16,395	1,451	1,458	19,304
Michigan	Clinton	109	6,292	1,030	921	8,243
Minnesota	Martin	178	15,516	1,722	1,731	18,969
	Stevens	267	9,279	1,721	1,298	12,298
Nebraska	York	197	9,394	862	789	11,045
N. Dakota	Cavalier	440	7,313	1,359	872	9,544
S. Dakota	Davison	290	6,999	723	1,263	8,985
Wisconsin	Barron	110	4,067	743	1,266	6,076
	Green	149	9,663	1,430	2,315	13,408

*Value per farm is based on average of all farms in the county.

†The value of machinery is based on the number of farms in the county reporting machinery.

‡The value of livestock is based upon the number of farms in the county reporting livestock.

Some additional capital is needed to provide feed, seed, and supplies.

of success are greatly increased. If, in a given locality, the best farmers are found to be worth only $4,000 to $8,000 at the end of a long period of years, one may safely assume that such a sum represents the upper limits of the possibilities in the region. It is well to profit by their experience. In such a region one should hesitate to take on heavy financial obligations.

Other Requirements. In addition to capital, a successful operator needs the practical experience that is acquired by growing up on a farm, participating in all phases of the farm work and planning or by working as a hired hand on a well-managed farm. Even if one has been reared on a farm, it may be advantageous to get the experience and viewpoint of capable farmers who are not relatives. It is advantageous to get part of that experience, if possible, by working at some distance from home, where the problems are different than in the home locality and will be more broadening.

One of the great advantages of the farming business is that parents can aid their children in gaining experience both in agricultural techniques and in business matters by giving them an opportunity to enter a junior partnership project, such as described in Chapter II, and participate in its financial management. In connection with these projects, modest amounts of money may sometimes be borrowed from interested individuals or commercial institutions. Such activities, if prudently conducted, may aid one to a better understanding of business practices. If one punctually cares for all such obligations, a reputation for trustworthiness will be established among those with whom he has business dealings. Such activities may enable one to build up a business asset in the form of "a good credit rating" which may serve well at any time that additional capital is needed for an emergency or for further expansion of the enterprise.

Supplying the Need. The need for capital will be supplied so far as possible from accumulated funds. These may have been derived from inheritance or gift, or as earnings from a junior partnership home project, or savings as a wage-earning farm hand or from some other similar source, or from a combination of these sources. The larger the accumulation of capital owned, the less need will there be for paying interest charges on capital that must be borrowed. When investing accumulated capital in farm property, one should make reasonably sure, however, that the investment will earn at least as much as it would if placed in a savings bank or used for the purchase of a government bond or other safe security.

If more capital is needed than the individual owns, it will be necessary to seek the additional capital from some individual or agency willing to supply it on a credit basis. The term credit, as commonly used, may be defined as the privilege of getting the immediate use of facilities or services, and paying for them at some later time, as agreed by lender and borrower. For the privilege of immediate use of the needed facilities or services, the borrower should earn enough by the use of them to pay interest on the loan. In many cases, when wisely managed or used, they may pay more than the interest rate. This result, in fact, is the hope of the borrower, and, perhaps, the impelling reason for seeking the loan.

In order to get credit advantageously, it is ordinarily necessary that the borrower be the owner of some money or property. This qualification is desired by the prospective lender for two reasons:

1. If the borrower has accumulated the money by his own efforts and self-denial, it is clear that he has solved the ever-present problem of living on a sum smaller than his income and is likely to continue to do so.

2. The accumulated capital, as a stake in the enterprise, serves as a guarantee that the obligation will be paid even though the venture should prove unprofitable. Before borrowing money, one should satisfy one's self that the contemplated investment will pay for itself and leave a good margin of profit. If the venture looks like a profitable one, it will also appeal to the lender, as the outlook for profits, together with a good reputation as an honest borrower, is a fair assurance that the loan will be repaid when due.

When Is It Wise to Borrow? The purpose of borrowing is to gain immediate use of money or capital goods that can be made to earn more than the cost of borrowing. A careful analysis of each venture for which borrowed money is to be used should be made to determine the probable returns from it. Unless definite gains are in prospect, it may be unwise to seek the loan. A method of analyzing a credit problem may be illustrated by considering a prospective purchase of five dairy cows at $125.00 each. Suppose that the cows have been located and are suitable. It will be well, before purchasing, to make some careful estimates of the probable results. A good starting point will be to consider the portion of the income from milk or butterfat that is likely to go for such overhead items as depreciation, interest, and death losses. These may be figured on a per-cow basis:

First cost	$125
Interest rate	6%
Useful life	5 years
Death loss (average of a large number)	2% per year
Final slaughter value	40
Production of butterfat, 300 lbs. per year @ 40c.	120

The following are the depreciation charges per year:

First cost	$125.00
Less final slaughter value	40.00
Depreciation in 5 years ($125 less $40)	85.00
Depreciation per year (1/5 of $85)	17.00

An approximate summary of the yearly overhead:

Depreciation	$17.00
Death risk, 2% on average value of $82.50	1.65
Interest on average value of $82.50 at 6%*	4.95
Total overhead cost per cow	$23.60

At 40c per pound of fat, it will require approximately 60 pounds of fat, or one fifth of the product, to meet the expected annual overhead of $23.60 for depreciation, death risk, and interest. If enlarging the herd by five cows requires additions or repairs to the barn, a bigger cream separator, or other equipment, then the annual depreciation, interest, and repairs on these items should be added to the overhead items already considered. As the expected production is 300 pounds per cow, the question is whether 300 pounds less 60, or 240 pounds of butterfat, will pay the feed cost, salt, water, bull service, and other expenses and still leave a worth-while return for the labor.

The answer may be further developed by more calculations. From Table V, page 37, *Agriculture II*, we find that a cow giving 300 pounds of butterfat annually will require:

1,500 lbs. of concentrates	Figured @ 1½c	$22.50
5,500 lbs. of hay or equivalent	" @ ½c	27.50
2 acres of pasture	6.00	6.00
Total feed cost		$56.00
Bull service and incidentals		5.00
Total cost per cow		$61.00
Value of 240 lbs. butterfat @ 40c		$96.00
Cost per cow per year		61.00
Returns for labor		$35.00

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* Interest is figured on the average investment in the cow (½ ($125 + 40) = $82.50), because, when depreciation is figured, theoretically, a certain sum is received from the investment in the cow and set aside toward replacing the cow when her usefulness is at an end.

Good dairymen figure that 130 to 150 hours of labor are required annually to care for a dairy cow. Allowing 140 hours in this instance, the $35.00 return to labor figures out at 25c an hour. This is a small return to labor. One should remember, however, that otherwise unsalable feeds may be marketed through livestock and that often the cows are cared for by family labor that must be supported whether employed or not. The 25c an hour may be practically clear gain if the labor would not otherwise be used. The loan may safely be made, as the overhead charges and feed are covered by the returns, with a modest wage to labor in addition. The return to labor may be increased by reducing feed costs or by increasing the yield of butterfat per cow by a more suitable feed ration.

In the case of beef cows, the estimates for overhead, depreciation, interest, and death loss can be measured against the value of each calf raised. In the case of ewes, one can estimate the return per ewe in the form of wool and lamb and deduct the overhead for depreciation, death losses, and interest. Then the question will be whether the calf or the lamb will show a profit after deducting feed and labor costs.

The wisdom of purchasing a machine may also be tested. Suppose that one must borrow for the purchase of a combine costing $1,000. Assuming a 10-year life, at 6% interest rate, $15.00 a year for repairs and $10.00 for taxes and insurance, the annual cost would be as follows:

Average annual depreciation	$100.00
Interest on average value of $500 (½ of $1,000=$500) at 6%	30.00
Repairs and upkeep	15.00
Taxes and insurance	10.00
Total	$155.00

The annual overhead of $155.00 plus the probable annual outlay for fuel oil and operating expense, may be compared with the cost of hiring the combining done. It may be better business policy to hire the work done for a year or two than to buy a combine for which there is not sufficient use to make it a profitable investment.

Many operators obtain loans without allowing for these overhead charges. As a result, they borrow more than the enterprise can carry and find that the loan, instead of being a help, has become a heavy debt burden.

SOURCES OF CREDIT

After figuring carefully the probabilities of gain or loss from the venture and measuring the need for additional capital, attention should be given to the sources of credit most readily available, and from which source it can be obtained on the most reasonable terms from the long-time point of view. Among these sources will be: (1) the seller of the goods, (2) relatives or other individuals having surplus funds, (3) Federal Co-operative Credit Agencies, (4) Government-owned agencies (F.S.A., Seed Loan, etc.), (5) commercial banks. Which source to use depends upon the amount of the loan, the rate of interest asked, and the length of time desired before repayment. Some agencies make a specialty of short-term loans, while others are organized to make long-time mortgage loans on real estate or business properties. The merits of these sources will be discussed.

The Seller As a Source of Credit. Very often the seller of livestock, machinery, equipment, or even of real estate is willing to take a moderate down payment on the sale and accept the buyer's note for the balance at an agreed rate of interest. The rate among such lenders varies greatly. In many cases, the note will be carried at about the rate that would be charged by a commercial bank on short-time "over the counter" loans. In others, the interest charge will be stretched to all that the buyer can be induced to pay. Unless the buyer has established a reputation for being "a good credit risk," the seller is quite likely to ask for a mortgage on the property sold or for other satisfactory security such as life insurance policies or government bonds.

It is not uncommon for storekeepers to carry farmer customers on grocery and supply items through the summer until crops are harvested. The borrower may feel that this concession is an interest-free loan. It stands to reason, however, that the interest charge is often concealed in higher prices for the goods purchased. One should open such accounts only with the full knowledge that the seller is not going without interest on goods advanced. Often the cost of the goods will be higher than if money is borrowed at a bank and cash is paid for them. Installment buying, which is often practiced by farmers as well as by others, also carries a hidden interest charge which should not be overlooked by the purchaser.

Farmers are more likely to purchase machinery on time than any other goods. Implement dealers are quite willing to offer credit to reliable farmers who make a fair down payment on the goods and give a secured note for the balance. Even though only the current rate of commercial loans is charged, the buyer may be paying more for the goods than is necessary. The following instance will illustrate this point.

A dealer offers a farmer a tractor for $1,000. He asks a down payment of $300.00, and will take the farmer's note for the $700.00 balance due in one year at 6% interest. The total cost of the tractor under this offer will be $1,042. The dealer offers to discount the price of the tractor $50.00 for full cash payment. The farmer has only $300.00 in cash. He can, however, obtain a bank loan for the $650.00 needed ($700 unpaid balance less $50 cash on discount) at 6% on a one-year note. By taking this latter course, he would pay $950.00 plus $39.00 interest on $650.00 or $989.00, for the tractor. There would thus be a saving of $53.00 over the first proposal, or 5.3% on the original price of the tractor. Or, to put it another way, the acceptance of the first proposal would have cost the farmer the equivalent of an interest charge of over 13% on the $650.00 loan.* Obviously, one should carefully analyze the alternatives before letting the seller "carry the loan."

Credit from Relatives or Other Individuals. Young men who are starting on a well-founded plan for operating a farm often get assistance from relatives or others interested in their success. A well-to-do father may be in position to give substantial financial support to a son or other relative. Sometimes such support may be given at little or no interest charge and without particular regard to the security for the loan. To that kind of support there can be but little objection unless it results in an injustice to other members of the family or may seriously impair the financial standing of the father. In the case of an only child, no question of partiality can be raised. Where there are several children in a family, it may lead to family quarrels unless similar favors can be granted to each. The same arguments apply to uncles, aunts, or other relatives who may take an interest in an individual and wish to help such a one to become established in farming. About the only advantages of loans from such sources are low interest rates, easier terms, and a tendency to "forgive" the loan, should the borrower experience a period of "*hard luck*" which is usually an alibi for poor management. The disadvantages lie in the hope that the borrower may insist on such leniency in a time of stress. Such concessions might result in less thrifty management and in family friction that might follow failure to make good. Should it be deemed advisable to accept loans from a relative, a full written agreement should be prepared in each instance, stating the amount of the loan and the terms upon which it is made. Supporting notes, mortgages, or other legal documents should be executed and filed just as would be done in making a contract with a commercial credit agency. Each party to the agreement should sign as required and have a copy for ready reference when desired. These steps, if followed, will avoid much difficulty, should an emergency necessitate probate court proceedings or other legal action.

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* Discount $50 + Interest $39 = $89—the total cost of credit. $89 divided by $650 = 13%, the actual annual cost of the credit.

While loans from relatives do sometimes work out satisfactorily, it will be better, in the long run, to obtain loans from institutions that are permanently in the loaning business and in a position to look after the loan in a business-like manner. Loans obtained from outside sources will not endanger the family relationships and in the long run are more advisable.

Bank Credit. Commercial banks organized under state and national charters are everywhere recognized as standard sources of credit for a great variety of borrowers. They were for many years, and, in fact, still are, regarded as a chief source of credit. Located in nearly every country town of moderate size, they may be conveniently reached and are usually in position to accommodate the prospective borrower on short notice. They are also in position to inspect the property on which a loan is desired and to complete their transactions without publicity. These features appeal to many borrowers and make such institutions attractive, particularly to those wanting short-term loans.

For many years banks and other commercial loaning agencies enjoyed a comparative monopoly in supplying short-term credit needs. They also supplied a substantial portion of the mortgage loans on real estate. During that period, high interest rates prevailed on both types of loans, and the real estate mortgages were usually for three to five-year terms. These two facts called for frequent renewals involving special fees for executing, filing, and recording papers. Under competition from co-operative credit institutions set up in recent years through congressional enactment and fostered by the Federal Government, rates and terms have been reduced and loans can be obtained from either source at more moderate cost than formerly.

FEDERAL CO-OPERATIVE AGRICULTURAL CREDIT AGENCIES

Within the past quarter century, special agricultural credit institutions have been developed under Federal supervision. They now hold a large place in meeting the credit needs of farmers. These institutions began in 1917 with the organization of the Federal Land Bank system, under Congressional Act of July, 1916. Further organization was authorized in 1923, when the Federal Intermediate Credit Bank was set up to assist in supplying credit to farmers by either discounting or purchasing short-term loans made by local Agricultural Credit Associations.* In 1933, through congressional enactment, the Farm Credit Administration was created with the expectation that it would meet all credit needs of farmers through the medium of co-operatively owned and operated credit institutions.

Under "The Farm Credit Act of 1933," the Federal Land Banks and the Federal Intermediate Credit Banks, which had been operating under the jurisdiction of an appointive Federal Farm Loan Board, were placed under the direction and supervision of a newly created and independent division of government, responsible to the President of the United States and to the Congress. At this time, two new units were added to the Agricultural Credit Group. These were the Production Credit Corporation and the Bank for Co-operatives. The new group was named the Farm Credit Administration. It consisted of the four credit agencies: (1) The Federal Land Banks, (2) The Intermediate Credit Banks, (3) The Production Credit Corporation, (4) The Bank for Co-operatives and was placed under a directing head known as the Governor of the Farm Credit Administration. The central administrative office of the Farm Credit Administration was established in Washington, D. C. In January, 1934, Congress authorized an additional credit agency known as the Federal Farm Mortgage Corporation to supplement the Land Banks in meeting the credit needs of farmers who were in danger of losing their farms through foreclosure during the depression emergency then prevailing.

The Federal Farm Mortgage Corporation was authorized to make second-mortgage loans in cases where there was a strong probability of repayment, but where the Federal Land Bank felt that the mortgage was not acceptable as security for land bank bonds that were being offered to the public.

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* In reality the F. I. C. B. does not always discount the notes. The present practice is to buy the notes at face value when acceptable under the regulations of the system. The F. I. C. B. then bills monthly the associations from which it has purchased notes, at the prescribed interest rate, which, in April, 1942, was 1½%. The associations making the original loans are allowed to charge borrowers 4½%. On the 3% differential the associations pay office rent, salaries, and other operating expenses, and meet such losses as may be incurred.

Under congressional authorization, the President of the United States, in April, 1939, transferred supervision of the Farm Credit Administration and the Federal Farm Mortgage Corporation, together with the Commodity Credit Corporation, to the United States Department of Agriculture. The Farm Credit Administration, which includes the central administrative offices, was, on May 1, 1942, temporarily moved from Washington to Kansas City, Missouri. Regional offices in each of the twelve Land Bank districts were authorized under the original Act of 1916. These districts are shown in Figure 16.

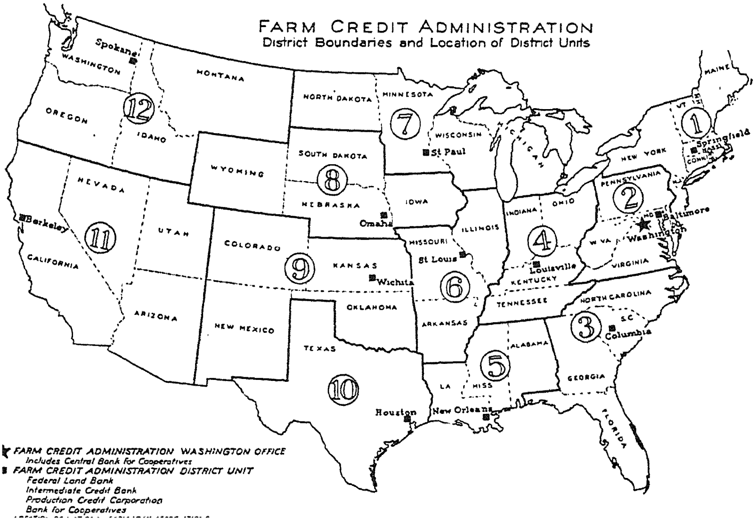

Figure 16. A map showing the district areas of the Farm Credit Administration.

At each of the district headquarters, there is: (1) A Federal Land Bank, (2) A Federal Intermediate Credit Bank, (3) A Production Credit Corporation, and (4) A Bank for Co-operatives. A Vice-President of the Federal Farm Mortgage Corporation represents the Corporation at each of these district offices and works in close co-operation with the officers of the Land Bank.

Functions of the Federal Land Banks. Federal Land Banks obtain money for making loans to farmers by selling Land Bank Bonds to commercial banks, investment brokers, individuals, or any others having money to invest. The loans are made through local organizations of co-operative credit groups of farmers known as National Farm Loan Associations. A secretary-treasurer is employed as manager of the Association office and general executive. A loan committee made up of member farmers is named, who pass upon the merits of the request and make recommendation. Loan inspectors are employed as needed.

A farmer who wishes to obtain a Federal Land Bank Loan makes an application to the Secretary-Treasurer of a local National Farm Loan Association serving the area in which the farm on which he wishes the loan is located. The Secretary, working with a loan committee composed of members of the Association, investigates the request and examines the farm. If satisfied that the loan is a reasonable one and that it probably can be repaid from the income of the farm in normal times, the application is sent to the Federal Land Bank of the district, with a favorable recommendation signed by the committee. The Land Bank then makes an investigation of the farmer and has the farm appraised. If the loan appears to be for not more than 50% of the value of land and 20% of the value of the buildings, and the borrower has a good reputation as a farmer and business man, the loan is approved and granted. A mortgage on the farm is made and the note endorsed by the National Farm Loan Association to the Federal Land Bank, thus to a certain extent co-operatively protecting the Land Bank against loss.* Land Bank loans are made on 20 to 34-year terms on a plan of amortization which usually requires twice-a-year payments on principal with interest accruals.

Each farmer obtaining a Land Bank loan must become a member of the Land Bank system by becoming a member of his local National Farm Loan Association. He is required to purchase stock equal to 5 per cent of the face of the loan, and pay an appraisal fee, the incidental expense of providing an abstract of title, and such filing and recording fees as may be necessary. In case the needs of the borrowers are not fully met by the Land Bank loan under the law as of April, 1942, a second mortgage loan may be made by the Federal Land Bank as agent of the Federal Farm Mortgage Corporation. The total of the two loans can not exceed 75% of the value of the mortgaged property. The authority to make such loans was extended to July 1, 1945, by act of Congress on June 26, 1943.*

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* The endorsement is made by the loan committee officially representing the N. F. L. A. involved and has the effect, when signed by the individual committee members, of putting the resources of the association back of the individual loan. It thus becomes a co-operative responsibility. These resources consist chiefly of the capital stock subscribed by the members.

The Individual Mortgage Loan Record form in Table VIII shows the payments due on a $1,000 mortgage loan at 4% and the distribution of the semi-annual payments as between interest accruals and principal payments due.

The advantages of a Federal Land Bank mortgage loan lie in the long-term amortization plan and a relatively low rate of interest. This plan relieves the borrower of the necessity of frequent mortgage renewals with the attendant expense and from the worry concerning possible inability to get it renewed. Interest rates of Federal Land Bank loans depend upon the interest charges the bank must pay to the investors for money which it uses for loaning purposes. The contract interest rate on Federal Land Bank mortgages in 1944 is 4%.

One contemplating a farm mortgage loan should visit the Secretary-Treasurer as the local representative of the National Farm Loan Association for his area, to get information about the possibilities for obtaining a satisfactory Land Bank loan.

Functions of Production Credit Corporations. Production Credit Corporations do not loan money to farmers directly. Their function is to supervise the operation of local Production Credit Associations which handle co-operatively short-term credit for farmers, largely for current operating expenses. Production Credit Associations are composed of member borrowers who run their association somewhat as a bank, but on a nonprofit basis. Each member borrower must purchase stock to the amount of 5% of the loan when the loan is made. Production Credit Associations usually operate over an area of one to several counties, depending on the density of population and prospective credit needs. Loans are usually made for three months to a year; but, in exceptional cases, loans are made to farmers operating in the area for periods of a few months up to 18 months. Chattel mortgages are required on loans made as determined in the judgment of the Secretary-Treasurer and the loan committee. The notes taken by the association are discounted † or purchased by the Federal Intermediate Bank when found to be acceptable,

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* Congress may or may not renew this privilege at expiration of the term, depending on need for credit of this type.

† For explanation of the term *discount* see footnote page 85.

Form 1201C

Transfers

4%

TABLE VIII

INDIVIDUAL MORTGAGE LOAN RECORD

THE FEDERAL LAND BANK OF ST. PAUL DISTRICT No. 7

LOAN No.

Name

P. O. *State*

Appr. *Land Val. $*

Dated

Matur.

Bldgs. $

PRINCIPAL, $1,000. RATE, 4% SEMI-ANNUAL INSTALLMENTS, $27.00 FINAL INSTALLMENT, $4.60

PENALTIES		AMORTIZATION TABLE							AMORTIZATION TABLE							PENALTIES	
Date Pd.	Amt.	YEAR DUE	NO.	INTEREST	PRINCIPAL	DATE PAID	INITIAL	BALANCE	YEAR DUE	NO.	INTEREST	PRINCIPAL	DATE PAID	INITIAL	BALANCE	Date Pd	Amt
		19	1	20.00	7.00			993.00	19	40	11.85	15.15			577.19		
		19	2	19.86	7.14			985.86	19	41	11.54	15.46			561.73		
		19	3	19.72	7.28			978.58	19	42	11.23	15.77			545.96		
		19	4	19.57	7.43			971.15	19	43	10.92	16.08			529.88		
		19	5	19.42	7.58			963.57	19	44	10.60	16.40			513.48		
		19	6	19.27	7.73			955.84	19	45	10.27	16.73			496.75		
		19	7	19.12	7.88			947.96	19	46	9.94	17.06			479.69		
		19	8	18.96	8.04			939.92	19	47	9.59	17.41			462.28		
		19	9	18.80	8.20			931.72	19	48	9.25	17.75			444.53		
		19	10	18.63	8.37			923.35	19	49	8.89	18.11			426.42		
		19	11	18.47	8.53			914.82	19	50	8.52	18.48			407.94		
		19	12	18.30	8.70			906.12	19	51	8.16	18.84			389.10		
		19	13	18.12	8.88			897.24	19	52	7.79	19.21			369.89		
		19	14	17.94	9.06			888.18	19	53	7.39	19.61			350.28		
		19	15	17.77	9.23			878.95	19	54	7.01	19.99			330.29		
		19	16	17.58	9.42			869.53	19	55	6.60	20.40			309.89		
		19	17	17.39	9.61			859.92	19	56	6.20	20.80			289.09		
		19	18	17.19	9.81			850.11	19	57	5.78	21.22			267.87		
		19	19	17.01	9.99			840.12	19	58	5.36	21.64			246.23		
		19	20	16.80	10.20			829.92	19	59	4.93	22.07			224.16		
		19	21	16.60	10.40			819.52	19	60	4.48	22.52			201.64		
		19	22	16.39	10.61			808.91	19	61	4.03	22.97			178.67		
		19	23	16.18	10.82			798.09	19	62	3.58	23.42			155.25		
		19	24	15.96	11.04			787.05	19	63	3.10	23.90			131.35		
		19	25	15.74	11.26			775.79	19	64	2.63	24.37			106.98		
		19	26	15.51	11.49			764.30	19	65	2.14	24.86			82.12		
		19	27	15.29	11.71			752.59	19	66	1.64	25.36			56.76		
		19	28	15.05	11.95			740.64	19	67	1.13	25.87			30.89		
		19	29	14.81	12.19			728.45	19	68	.62	26.38			4.51		
		19	30	14.57	12.43			716.02	19	69	.09	4.51					
		19	31	14.32	12.68			703.34									
		19	32	14.07	12.93			690.41									
		19	33	13.81	13.19			677.22									
		19	34	13.54	13.46			663.76									
		19	35	13.28	13.72			650.04									
		19	36	13.00	14.00			636.04									
		19	37	12.72	14.28			621.76									
		19	38	12.44	14.56			607.20									
		19	39	12.14	14.86			592.34									

(INTEREST PAYMENTS RULED OUT ARE NOT PAID)

Pursuant to the provisions of The Federal Farm Loan Act, the undersigned National Farm Loan Association hereby indorses and thereby becomes liable for the payment of the indebtedness evidenced by the within note, in accordance with the terms of said note and mortgage and the provisions of said Act.

In Witness Whereof, the said National Farm Loan Association has caused this endorsement to be executed for it and in its name by its Secretary-Treasurer

The ______ National

Farm Loan Association of ______

By ______

Its Secretary-Treasurer

thus providing the association with funds with which to make additional loans. The interest rate charged by associations to farmers depends upon the interest rates the associations have to pay to the Federal Intermediate Credit Banks for loan funds. That, in turn, depends upon what the Federal Intermediate Credit Banks have to pay on the money they get from the investing public by selling short-term securities and upon the spread required to properly conduct the P.C.A. business. The interest rate charged at the end of the year 1943 was 4½%.

The Federal Intermediate Credit Bank. The Federal Intermediate Credit Banks function merely as discounting institutions for Production Credit Associations and privately organized Agricultural Credit Corporations and banks. They do not lend money to farmers or others directly. These banks serve agriculture by making it possible for farmers operating in groups to reach the large money markets of the world, thus gaining the advantage of lower interest rates. Farmers deal with the Federal Intermediate Credit Bank only through the Production Credit Associations, Agricultural Credit Corporations, or other agricultural loaning institutions.

The Bank for Co-operatives. A Bank for Co-operatives is included in each Farm Credit Administration district. There is also established a Central Bank for Co-operatives at Washington, D. C. These banks make loans only to agricultural co-operative organizations engaged in providing for co-operative farm services, such as Farmers Elevators, Co-operative Creameries, Co-operative Oil Companies, and Co-operative Canning Companies. They may supply funds to any co-operative engaged in purchasing or marketing farm supplies and goods of an agricultural nature. Funds are supplied through these co-operative loans at low interest rates, varying at the end of 1943 from 1½% to 3½%, depending on the nature of the loan and the purpose for which made. No loans are made direct to farmers by the Banks for Co-operatives or to other than agricultural co-operatives.

Loans from Government-Owned Lending Agencies. During the depression and drouth period prevailing 1929-39, several agencies other than those just described were authorized by Congress and supplied with Federal funds to give assistance to farmers who were seriously distressed by crop failures, low prices, and other circumstances over which they had little or no control. Among these were:

1. The Farm Security Administration, authorized to make

closely supervised loans for the purpose of supplying operating capital to those attempting to become established on farms but who are unable to obtain credit from Production Credit Associations, National Farm Loan Associations, or Commercial Banks.

2. Seed Loan Administration, a division of the National Farm Credit Administration, the function of which is to enable stricken farmers who lost their crops by drouth, hail, or other calamity to get seed grain for another attempt at crop production.

3. The Tenant Purchase Act providing loan funds with which to assist capable tenants to become farm owners.* Under Federal and local investigation and supervision, farm properties are purchased, equipped, and operated. As progress is made toward ownership and in skill as a farmer, the farmer more and more assumes entire responsibility for the operation of the farm and is expected eventually to pay off the loan and own the farm clear of debt.

4. Rural Electrification Administration, specifically to aid in the provision of electric current and to enable farmers to purchase equipment for electric lights and power on farms.*

Insurance Company Loans. Insurance companies have been an important source of real estate credit in the better farming areas. Farm mortgages have been looked upon in the past as good investments and carried high interest rates, but insurance companies buying farm mortgages as investments have unexpectedly and unavoidably acquired many farms through inability of borrowers to pay the interest charges and meet payments on the mortgages. These have been carried by the companies and operated by tenants until they could be resold. Sales of such farms are now being made on long terms of repayment and at favorable interest rates.

WHAT SOURCE OF CREDIT SHALL I USE?

The obvious answer to that question is to get the loan wherever it can be obtained on the most suitable long-time servicing terms and the lowest long-time cost in fees and interest. It, therefore, becomes a matter for investigation and careful calculation. The nature of the enterprise for which funds are wanted, the prospects for profitable use, and plans for repayment all enter into the problem. Sometimes it may be wise to accept a loan from a fair-minded seller of the goods or commodity wanted, if terms and rate are as good as can be obtained elsewhere. Usually, however, one finds that interest payments to such sources run rather high. The easy policy of borrowing or buying on time from a number of sellers is likely to lead to an accumulation of debts on which more direct or indirect interest will be paid than would be paid where funds are borrowed in one place and cash paid for the purchases. One should shop around and bargain for credit just as one bargains for a new machine, a suit of clothes, or any other commodity or goods wanted. The loan obtained, however, should fit the need and purpose for which made.

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* These four sources are looked upon as emergency sources and in so far as new business is concerned are subject to reorganization or withdrawal by Congress at any time.

GOOD REPUTATION VALUABLE TO BORROWER

It is an asset of importance to a farmer to establish a reputation for being a "good credit risk." He can do so by following careful business methods. Some of the things he must do to establish such a reputation are:

1. Borrow only when absolutely necessary. The reputation of buying wisely and paying cash for all goods purchased not only saves money in the end but quickly adds to the credit standing of the farm operator. Loaning agencies are reluctant to loan to those who are accustomed to running store bills and buying on time or installment plans. The one who pays cash is entitled to a better price than one who asks the dealer for time in which to pay. He may not get a concession for cash, unless he asks for it. If he does not get it, he is helping the seller to "carry" those who do not pay cash.

2. Promptly meet all obligations when due. If, for any reason, the loan can not be repaid when due, see the lender and, if possible, arrange a renewal. Promptness in meeting notes and other obligations when due adds greatly to one's standing as a credit risk. Credit agencies keep an accurate record of the progress made by borrowers and of the way in which they meet their obligations. Failure to pay a note when due or to renew the note, if it can not be paid, is a serious default, which may react against the borrower when another loan is needed. If, through some adverse circumstance beyond the control of the borrower, it becomes impossible to pay the note when due, the problem should be discussed promptly with the lending agency with a view to having adjustments made and a renewal arranged.

3. Borrow for productive purposes only. Usually, farmers borrow money to make more money. To accomplish this purpose,

borrowed money should be used for productive purposes. Money borrowed to purchase seed or fertilizer is likely to be returned in the resulting crops. Money borrowed for a vacation trip or a radio or for painting a building is not likely to add anything to the ability of the borrower to pay the loan. The purchase of an additional cow or brood sow would add more to the productive power of the farmer and more nearly insure the repayment of the loan.

4. Work out a reasonable repayment plan. Plans for repayment should be made before a loan is requested. Loans for crop production may well be timed to payment when the crop will be harvested and sold. Loans made for the purchase and fattening of beef cattle, lambs, or other meat-producing animals should be repaid when the animals are sold. Loans for longer time production turnover should be for longer terms, with provision for partial payment from time to time. If dairy cows are kept, a certain percentage of the monthly cream check is frequently applied to the payment of the loan.

5. File with the lender a financial and net-worth statement which should be renewed annually to show progress made. Well-established lending agencies now require credit statements from customers before making loans. Farmers sometimes object to giving such statements on the ground that it is giving publicity to what they regard as their private business. But the one who asks another to share a risk with him should willingly give full information as to how great a risk is involved. An annual inventory, together with an operating summary statement of receipts and expenses, will give the information wanted. Such summaries are useful not only in securing the loan but also aid the operator to measure the progress being made. There should be no hesitancy on the part of the borrower in furnishing the lender such a statement as a factor in getting the desired loan.

HOW MUCH SHOULD I BORROW?

Since interest must be paid on borrowed money and interest adds to the costs of operation, it is obvious that the less borrowed, the less the expense. Many farmers are tempted to borrow too much. Frequently, one will say, "I need all I can get." There is grave danger that one who must have "all he can get" will not be engaged in farming permanently. Any adverse circumstance, such as illness in the family, poor crops, unexpected low prices, animal diseases, or a combination of these may put him at the mercy of his creditors. It may become necessary for him to sell all his property to satisfy the obligations. If the property does not bring enough to cover the debts, an embarrassing judgment against future earnings of the creditor may be awarded to the lender. A safe rule is to borrow the least that can be made to serve the purpose in view. The largest possible short-term loans should be used only in a dire emergency.

GIVING CHATTEL MORTGAGES ON SHORT-TERM LOANS

Until a good reputation as a credit risk has been established and a satisfactory credit statement can be shown by the borrower, security of some kind is usually required on short-term loans. The security may be composed of high-class stocks or bonds, life insurance policies, or other salable collateral. In the absence of such collateral, a chattel mortgage may be required on the goods or property covered by the loan. Many farmers hesitate to give mortgages on personal property for fear of losing it if the loan is defaulted for any reason. Since, through a judgment gained by court action, any property not exempt by law can be taken to satisfy the claim, there is little reason for withholding a chattel mortgage except on that property which is exempt from execution. Under the laws of most states, 40 to 160 acres of land and a modest amount of the most necessary personal property is exempt, and, if free from mortgage, can not be taken to satisfy a debt. Few farmers, however, wish to take advantage of the exemption laws to enable them to dodge the payment of legitimate debts.

There are valid reasons for avoiding chattel mortgages, however, which well may be noted. In the case of sale of livestock, grain, or other products covered by a chattel mortgage a good title can not be given without a release from the holder of the mortgage. This is sometimes hard to get, particularly if the proceeds are wanted for any purpose except to apply on the note which is secured by the mortgage. Even though the remaining security is more than ample for the size of the loan, the holder of the mortgage may refuse to give a release unless the proceeds are applied on the note. Sale of the property without turning over the funds to a mortgage holder is punishable by prison sentence, unless arrangements are made with the mortgage holder for a release of the security.

Another reason for avoiding a chattel mortgage, if possible, is that mortgaged property can not be moved freely from county to county or from one state to another without renegotiating the deal. There is no disgrace in giving a chattel mortgage, but it does sometimes result in inconvenience.

PURCHASING REAL ESTATE ON CREDIT

Nearly all purchases of farms involve the use of credit over a period of years, with the purchased real estate used as security for the loan. If, as a tenant, one has succeeded in accumulating good livestock and machinery equipment free of debt and in addition has a substantial sum of money with which to make a down payment, one is in a position to consider the purchase of a farm. One's whole future financial success is at stake in the purchase of a farm. The deal, therefore, should be carefully considered from every angle. If a man is buying a farm which he has worked as a tenant or one that he has had under his observation for several years, he is much more likely to make a satisfactory deal than if he has seen it only once or twice before buying. Usually, one finds that a farm purchased after only one or two inspections is not as desirable as it was thought to be.

In buying a farm, the purchaser sometimes takes one that needs repairs to the buildings, eradication of weeds, drainage, land clearing, or other improvements, because it can be secured at a lower price than one in good condition. If the inferior farm is purchased, the cost of the improvements should be carefully calculated with the aid of someone who is well experienced in such matters. Due allowance should be made for the fact that the better farm will be fully productive from the start.

Frequently, one finds, after such calculations are made, that the higher-priced one of two farms under consideration may be the cheapest. If one buys the higher-priced farm, the improvements are already financed as a part of the purchase money contract or mortgage. If one plans to make the improvements from time to time and has put all his available cash into a down payment on the farm, probably the only way in which he will be able to finance the improvements will be either to put a mortgage on his cattle or equipment or to buy needed material from dealers on open account or by installment contracts. Either method is likely to be embarrassing and costly, as most improvements do not pay for themselves rapidly enough to warrant getting them on short-term credit.

A method of summarizing the comparative desirability of farms is illustrated by a case in which a prospective purchaser was comparing two farms thought to be fairly similar as regards both buildings and soil except that farm No. 2 was in a run-down condition. The barn needed a new roof, paint, and repairs to the foundation. The machine shed, chicken house, and granary needed $150.00 for repairs to roofs, doors, and foundations. The farm fences were in poor condition, and it would require an expenditure of $500.00 to make them the equal of those on farm No. 1. There was a low spot that needed tiling at an estimated cost of $500.00. The well and water system needed repairs. There was one 40-acre field that was badly spotted with black bindweed, and it was estimated that at least $400.00 would be required to eradicate it. The figures, when summed up, showed that, even though Farm No. 2 could be bought for $8,000 as compared to $10,000 for farm No. 1, the actual cost of the properties, when both were put in about the same condition, was substantially more in the case of farm No. 2. Here are the figures:

	Farm No. 1	Farm No. 2
First cost	$10,000	$ 8,000
Building repairs, house	......	200
barn	......	500
other buildings	......	150
Drainage	......	500
Fencing and repairs	......	500
Well and water system repairs	......	100
Weed eradication	......	400
Total cost	$10,000	$10,350

The down payment required in each case was $3,500. That was all the funds available to the buyer for a down payment. If he had bought farm No. 2, he would have had no money left with which to make improvements and could not have borrowed it advantageously. In the case of farm No. 1, all these improvements were included in the purchase price and financed on the more favorable basis of a real estate loan. The farmer decided to buy farm No. 1. On farm No. 2, most of the needed improvements would have been long delayed, due to lack of funds. As a result, the income would have been substantially less than on farm No. 1 because of poor drainage, weedy land, and lack of fencing. As a result, the $4,500 unpaid balance in the case of the No. 2 farm would have been harder to pay than the $6,500 balance in the case of farm No. 1. This farmer made a wise decision when he purchased farm No. 1.

Amount of Down Payment. There is a substantial difference of opinion as to the portion of the purchase price that should be in hand for a down payment. Much depends on the certainty of crops in a given region and upon the age of the farmer. Generally speaking, a man who is 30 to 35 years of age, who has good health and is buying in a region that has hardly ever had a crop failure, might be justified in buying with a 25% down payment, particularly if the price seems to be well justified by the earning ability of the land.

In regions where crops are a bit uncertain, it is desirable to have a sufficient down payment, so that well-established lending agencies will take a first mortgage for the unpaid balance, unless the seller is willing to enter into a contract whereby the amount of the annual payments will be determined by the income from a share of the crop in excess of that needed by the operator for living and carrying on operations.

In buying a farm, it is helpful to inquire carefully into the success of previous operators. If one finds that tenants who have farmed the place have accumulated funds for a substantial down payment on a farm or that previous purchasers have been able to pay for the place, it is reasonable to suppose that it may have the same possibilities for others. If previous operators have made no progress or have gone backwards, one is likely to receive the explanation that they were poor farmers; that all that is needed is a good farmer. You may be sure that you can supply that lack. One should be very certain, however, that a large part of the difficulty did not lie in poor soil or other deficiencies of the place. Perhaps the so-called poor farmer was just as capable as you but found he had handicaps that could not be overcome.

One should carefully set down the income that can conservatively be expected from each source. This preview should be followed by a detailed list of the probable cash outlay for interest, payments on principal, taxes, labor, purchased seed and feed, machinery repairs and upkeep, building upkeep, fencing, and family living. The more intimately one is acquainted with the farm, the more accurate are likely to be the estimates. In buying a farm on credit, one should always be on guard against assuming that there will not be a considerable number of difficulties with weather that is too dry or too wet, late and early frosts, insects, plant and animal diseases, and prices that are lower than one expected.

PROTECTING FARM INVESTMENTS

Farming is subject to many hazards and risks. These should be guarded against in every possible way. Some hazards can be guarded against by forethought and good management. Others are not under the control of the farmer, and must be guarded against as circumstances permit. Full crop yields and efficient, economical livestock production are large factors in enabling the farmer to pay his debts and gain ownership of his farm. If the selection of the farm has been wise, and good soil and a favorable climate are at the farmer's command, he can do much to avoid the penalty of low production.

Protecting Production. By providing drainage where needed, stopping incipient gulley erosion, supplying fertilizer, practicing crop rotation, controlling weeds, preparing the soil well, and using good seed, the risk of low crop yields is greatly reduced. The ravages of plant diseases, and attacks by insect pests can frequently be avoided by seed treatment and by spraying with insecticides. To provide these forms of protection lies within the power of most farmers. To fail to provide any of these measures of crop protection is to invite low crop yields and endanger the farm income. Resulting low income may in turn result in inability to meet interest accruals and promised payments on principal. Foresight protects against such risks.

In like manner, livestock production can be freed from many of the incidental risks and net income from production increased by exercising foresight in planning carefully for adequate feed and pasture, vaccination for certain diseases, and following the best known methods of feeding and of livestock sanitation.

Most of this protection can not be purchased ready-made. It must be obtained by every-day vigilance and responsibility for the growth and well-being of the crops and livestock in which lie the debt-paying income of the farmer. Good crop and livestock management is one of the best possible forms of protection of investments available. Its best feature is that it can be gained without material cash outlay.

Protection Through Insurance. Insurance is a means of spreading risks over a group of farms or of individuals. In most localities, insurance against loss of crop by hail is available at a relatively low cost. Thus a farmer, if he chooses, may share with neighbors the loss of a crop or crops, which, if carried alone, would seriously impair his yearly income and possibly prevent the payment of urgent note or mortgage obligations. By carrying crop insurance, the risk to the individual is reduced to a small annual expense. While this expense might be saved by not carrying insurance, loss of crop might result in financial disaster on a heavily mortgaged farm.

The Federal Government, through the Agricultural Adjustment Act, during the drouth years has developed insurance plans to cover either loss of crop or low yields of wheat and cotton due to drouth, hot winds, hail, or other calamity. Farmers operating in a region subject to losses from climatic disturbances should thoroughly investigate the probabilities of loss of crop, the cost of insurance against loss, and the need in each individual case of dividing the risk of loss with others.

Fire and Wind Insurance. Most farm owners carry Fire and Wind Insurance on their buildings and contents. Fewer tenants carry insurance, because they ordinarily have no investment in the buildings. They will do well, however, to carry a reasonable amount of insurance on livestock, stored grain, feed, implements, and other personal and household property. Ability of a tenant to continue in farming after a disastrous fire often depends on the funds derived from insurance.

Life Insurance. Without going into a discussion of forms of policies or terms of insurance, farmers, and especially young farmers, who are operating under a heavy debt load, are urged to consider fully the wisdom of carrying a reasonable amount of accident and life insurance. As a means of protecting investments already made, it is a good business asset. Even more important is the wisdom of providing, in case of death, a means of livelihood to a wife and family of young children. For farmers who are heavily in debt, policies that emphasize protection, such as straight-life policies or possibly term policies are to be preferred to those that emphasize investment, such as 15 or 20-year endowment policies. Accidents are quite as common on farms as elsewhere, and coverage can usually be secured at reasonable rates. In an emergency the insurance payment may go far toward covering the expense for medical care or toward hiring extra help during temporary incapacity. One should not overlook the fact that a person protected by a life insurance policy is a better credit risk than one not protected. The initial cost may seem high and an embarrassing burden, but the policy itself may be used as collateral for small loans, saving possible recourse to chattel mortgages on livestock or crop products. The one heavily in debt needs such protection more than one whose indebtedness is less.

Suggestive Questions

1. What is your definition of the term "credit"?
2. When is one justified in using credit?
3. What is the danger in buying on the installment plan?
4. Am I (you) a good credit risk? If not, why not?
5. Are interest rates on short-term chattel loans higher or lower than on real estate loans? Why?
6. What is meant by an amortized loan?

Suggestive Activities

1. List by name and location all credit agencies doing business in your community.
2. Make a thorough inspection of some farm for sale in your community and write a report of its desirable and undesirable qualities.
3. Make a careful study of a farm business for which you have the records; determine the net income and from that determine the value per acre of the farm.
4. Determine the usual cash rent paid per acre in your community for farm land and calculate the value of the land if capitalized at the customary interest rate in the community.

CHAPTER V

MARKETING THE FARM PRODUCTS

Farmers plant crops and raise livestock because crop and livestock products are wanted for food and clothing. Some products of the farm may be used to make other products in industry—as linseed oil from flaxseed, plastics from soybeans, and alcohol from grains. Somebody wants them and is willing to exchange other products for them. Production, then, is for consumption, the satisfaction of human wants.

The pioneer farmer produced crops and livestock products which he and his family could use in order to live. He had to depend on his own production for the essential needs of his family. He produced wheat which he ground into coarse flour that his wife baked into bread. At first he depended on game and fish for meat, keeping cows to produce milk. Eventually he butchered cattle and hogs for meat, and raised sheep to produce wool to make clothes for the family. The pioneer family was self-sufficient.

Soon, however, he was producing more of those goods than he needed for his own use—he had a surplus to sell; but he still had wants he could not supply. He wanted coffee, tea, pepper, and other groceries. He could grow only those crops that were adapted to the climatic conditions of the area in which he lived and to the nature of the soil.

Today, all over the world, a great variety of desirable goods is being produced. In our own country we have the Dairy Belt, the Corn Belt, the Cotton Belt, so named because each area has a natural advantage in the production of dairy products or corn or cotton. Dairy products can be produced in the Cotton Belt. Cotton can be grown in the Dairy Belt under greenhouse conditions but at a disadvantage and higher cost. Crops are produced at lowest cost when climate, natural resources such as soil minerals, water power, and labor supply offer the greatest advantage to their production at the least disadvantage. This is the law of natural advantage. From all parts of the world, also, our own products are supplemented with almost endless commodities which can not be produced in our own country.

Along with natural advantage, specialized effort makes economic or low-cost production possible. Farmers produce crops and livestock suited to their farms and to their farming areas and to their individual ability or likes to produce them. Some farmers are said to be good dairymen or good crop men or good hog men, and, because of their ability, specialize in the production of such products. Specialization in industry has gone much further, resulting in highly efficient and low-cost production. The packing industry is an excellent example of specialization or division of labor where each workman does a certain job until he has developed extreme proficiency in it. An assembly of such specialized workmen makes the entire plant highly efficient, resulting in low-cost production. The automobile industry is a similar example of specialization, resulting in the production of an enormous number of cars at a price that consumers can afford. Contrast with this picture the attempt of one person to build an entire car by himself. It is said that it would take 12 years to complete it at a cost of $17,000 and then it would be a 12-year-old model.

Farmers and industry are producing a wealth of goods far beyond their own needs, but available for use by others engaged in other specialized production, so that there is an abundance of goods not only for ourselves but for world-wide consumption. As many goods are produced at a distance from where they are used or consumed, large industries require great numbers of laborers and a concentration of population in many cities. The producers are separated from the consumers of their products, and, therefore, communication and transportation are involved, since the products must be brought to the consumers when and where they want them.

The production of this wealth of goods by farmers and industry, at widely separated places, would be needless if there were no device to make the exchange of goods possible. If goods can not be exchanged they will not be produced. The Indian bartered or traded furs for guns, ammunition, and tobacco. A stack of beaver skins as high as the length of a rifle was regarded as the exchange value of the rifle. A cow could be traded for 6 pigs, in which case the exchange value of the cow would be 6 pigs, and the value of a pig would be 1/6 of a cow. Obviously such a system is impossible today, but it is still necessary to determine exchange value and measure it in some medium of exchange. The Indians used wampum or beads for this purpose. We use money (dollars and cents) as a common denominator of value. The exchange value is determined in terms of dollars and cents which we call price.

Thus we have a wealth of goods of all kinds produced by farmers and others under highly specialized processes operating under natural advantage to bring forth a mass of production at low cost—all made possible by a system of exchange of products.

The problem is to study ways of distribution and exchange of goods among widely separated producers and consumers, so that the wants of all may be satisfied as completely as possible. Marketing is the device that makes this exchange possible.

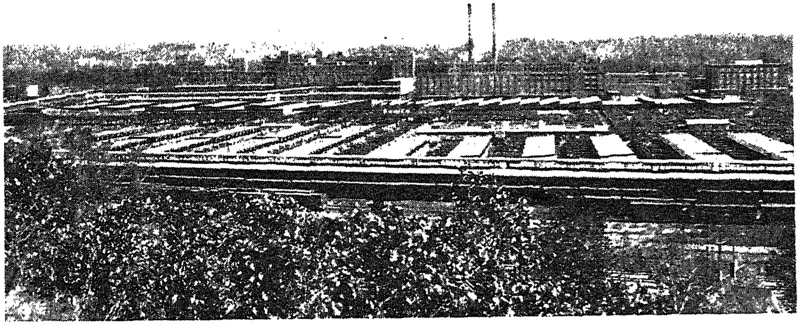

Figure 17. View of a livestock-terminal market, where farmers find a ready sale for their livestock. Buyers and sellers meet in the pens and yards where offers are made and accepted. Close at hand are packing houses with the facilities required for converting the animals purchased into edible food products.

WHAT IS A FARM MARKET?

A market may be defined as a place where buyers and sellers meet, and where goods are bought and sold. In this sense, it might be a farmer's roadside stand, a market square in his local village, a creamery, an elevator, or a livestock yard. In a broader sense, but still in a place, a market may be located in a distant city in such a place as the grain exchange building, the stock yards, at a terminal livestock market, or at a produce exchange where farm products from a large area are sold. In a still broader sense, it may be at a world center where goods coming from many countries are sold and their exchange made possible. Liverpool used to be the world market center for wheat, because more wheat was sold there than anywhere else. At present, Chicago is the world center for wheat sales. This definition of a market as a place does not describe a market completely, because it does not explain who buys there or how the farmer is represented in the sales.

A market may also be defined as a number of jobs that must be done to bring the farmer's products to the consumer of those products. This collection of jobs is made up of hauling, buying, selling, sorting, grading, and processing the products as they come from the farm and then distributing the finished products through wholesalers, jobbers, and retailers to the consumers for whom they were produced. The job may be simple, as when a farmer sells his milk, eggs, fruit, and vegetables direct to a consumer who stops at the farm or who lives in a neighboring village or city. In such cases the farmer performs the entire job of marketing himself. The bulk of farm products is not marketed in this simple manner and must pass through many hands before it reaches the consumer. This description of the job of marketing will be discussed in more detail in the section on the functions of a market.

Finally, a market may be defined as the result of a series of conditions or forces that influence and determine prices of farm products. The market is described as weak, steady, or strong, depending upon whether the price is going down, is stationary, or is going up. The farmer with grain to sell calls the elevator to ascertain the condition of the market before he decides whether to sell now or to wait for a rise in price. The factors affecting price will be considered in the section dealing with market price.

A market then may be defined as, (1) a place where goods are bought and sold; (2) a collection of jobs that make the sale of farmers' products possible; and (3) the result of a series of conditions and forces playing on and determining the price of farm products. The term "market" may thus have three meanings, each contributing to an intelligible picture of the overall process of the sale of farm products.

MARKET PRICE

Price is the amount of money for which a unit of any given goods may be exchanged at a given time and place. Market price is the price at which the bulk of sales is made at a given time and place, that is, it is the common or typical price. A single sale does not fix the market price, as it may be high or low, depending on particular circumstances. The market price for wheat is the price paid per bushel for the bulk of wheat bought at an elevator at a particular point for a given day and is the local market price. Local market prices are based on market prices at terminal markets when sales from a large area are made and are lower than terminal prices by the cost of handling and transportation to the terminal market. Terminal market prices in turn are based on the market prices of finished products as flour, meat, etc. Market prices of farm products at terminal markets are usually quoted daily, reflecting short-time changes in the factors affecting price. The daily fluctuations in market price are usually small and move in relation to supply and demand over a longer term. This long-time price depends on crop prospects not only in this country but in other countries, on numbers of livestock on farms, on changes in consumption or purchasing power of the consumers, and on the cost of producing farm products. Changes in this long-time price

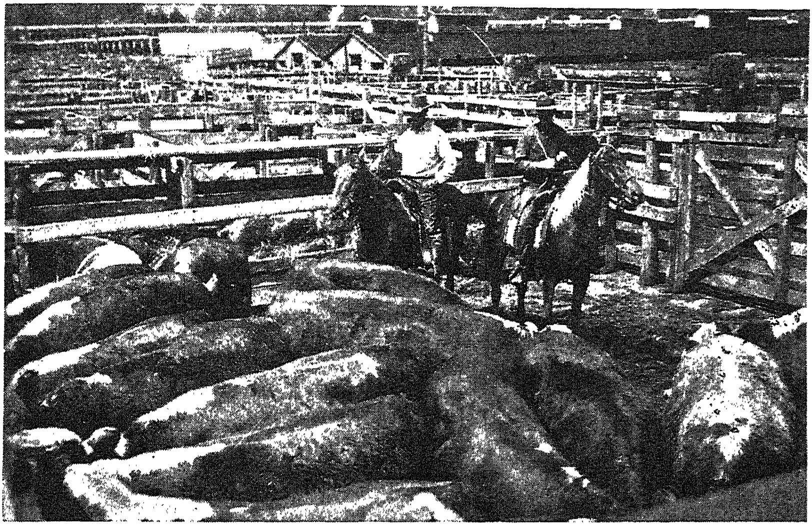

Figure 18. Reaching an agreement on price in the cattle pens at a livestock market. Here the cattle are fed, watered, and sorted in preparation for sale. Buyers then visit the pens and make offers to buy. When a sale is made, the cattle are driven to the scales and weighed and charged to the buyer.

level are usually gradual. Around this level, the market price of farm products fluctuates as it is influenced by supply and demand and bargaining activities of market men.

Market prices are determined normally by the interaction of supply and demand in the market place.

Supply Defined. Supply is defined as the amount of goods a seller or sellers stand ready to offer during a given time in a given market at a given price. There is a relationship between amount and price, since, if the price is high, a larger amount is offered for sale tending to increase the supply and reduce the price. Low prices tend to reduce the supply.

The supply of farm products depends on the willingness and ability of farmers to produce. If prices for a given product are high at the time a farmer is planning his farm program, or conditions indicate that prices will be high when the product is ready for sale, he will tend to provide for an increase in production. If prices are low or prospects indicate a lower price, he will tend to reduce his production.

The present supply of farm products is made up of the products carried over from the production of previous years and the production of the current year. For example, the domestic supply of wheat for the marketing year, July 1, 1942, to July 1, 1943, was estimated at 1,524 million bushels, due to a carry-over of 620 million bushels from previous years and an indicated crop of 904 million bushels for the 1942 crop. Products from foreign countries must be considered in total world supply as a price-determining factor.

Demand Defined. Demand is defined as the quantity of goods a buyer or buyers are ready to buy at a particular price during a given time at a given place. It is made up of a desire for certain goods together with an ability and willingness to pay for them. Merely wanting goods without the means of paying for them does not constitute economic demand. People often want many more goods than they are able to buy. Ability and willingness to pay make desire and need effective in the demand as a price-determining factor. The wants and needs of people are seldom entirely satisfied everywhere, and the ability to pay for goods is usually not sufficient to buy all the goods desired. Furthermore, the more money people have to spend, the more wants and desires they are likely to develop. Likewise, a lower income tends to discourage new wants. Hence ability to pay, or purchasing power, is an essential part of demand as a price-determining factor. Conditions that affect income or purchasing power of consumers are (1) general business activity affecting the number of people employed, (2) the number of hours worked, (3) the wages paid, making up factory payrolls. When business is good generally, farmers can sell their products at higher prices and realize larger incomes. The total of payments made to individuals make up the national income which indicates the purchasing power of the nation. How much can be sold in foreign countries is determined by the business conditions there, and the extent to which they can supply their own needs, and the crop conditions and restrictions that interfere with exchange of goods among countries.

If demand for farm products, desire or need for such products, and ability to pay for them are relatively stable and uniform, a relatively large supply of farm products results in lower prices, while a relative scarcity or short supply of them results in higher prices. Higher prices stimulate increased production, thus increasing supply relative to demand. Lowering prices in turn tend to discourage production. The interaction of supply and demand, in relation one to the other, determines the price which tends to produce a balance between supply and demand and a tendency toward more complete satisfaction of human wants and desires.

The supply of farm products is relatively uncertain, since it depends much on climatic conditions, seasons, and biologic conditions. It appears to vary more than demand for such products and hence farm prices may be said to fluctuate more than prices for manufactured goods where production can be more nearly controlled.

FUNCTIONS OF MARKETING

A market can perform its function of disposing of farm products most satisfactorily only if the process of production has been well planned and performed. It is difficult to tell exactly where production ends and marketing begins since the farmer's program of production and choice of crops is aimed at the market for those crops. The farmer produces what he believes he can sell to the best advantage. How good a product he produces and at what cost are important factors affecting how easily he can sell, at what price, and at what net profit. He must produce what the consumer wants and is willing and able to buy. High-quality products produced at low cost sell readily at a price that can reflect profit easily. A product well produced is on the way to being well sold. No system of marketing can be devised to sell low-quality products at a satisfactory profit, especially if they are produced at high cost. Planned production, carefully executed, goes a long way to assist in the job of marketing. For practical purposes, marketing begins with the farm product as it is produced or harvested in the natural form: wheat as it comes from the thresher; vegetables and fruits as they are gathered; and livestock as it stands in the feed lot. These products on the farm are still a long way from the consumer's table in the urban center. It is the function of marketing to help the farmer to sell them and the consumer to buy them. Marketing bridges the gap between the producer and the consumer.

The various services or functions that make up marketing include assembling, sorting, grading, processing, packaging, storing, transporting, financing, and distributing. These all render a service to the farmer in selling his product and to the consumer in giving him the goods he wants when and where he wants them. Crops are frequently produced a long distance from the consumer. Wheat produced in Kansas may go to New York City. Potatoes from Idaho may be sold in Chicago and other large cities. Neither can be entirely consumed where produced. Farm products must be moved from the farm into the channels of trade in the process of reaching the consumer. Transportation is an essential function of marketing.

Processing Necessary. Farm products as produced are usually in a raw or unfinished state and not in the form the consumer wants. Live hogs would be useless in the hands of the average consumer. Wheat is consumed as bread, not as wheat. It must be ground into flour, combined with other ingredients, and baked into bread before it is in the form the consumer wants and buys. Most farm products must be processed before the consumer will buy them.

Many farm products such as cream, butter, fresh fruits, and vegetables, if transported long distances, must be shipped in refrigerated cars and kept in cold storage until the time comes for putting them on sale—oranges, grapefruit, apples, and other major fruits are carried in cold storage over many months to prolong the season over which they are available and to avoid glutting the market at the height of the season.

Storage Required. Farm products must be stored on their way to the consumer. Crops are usually harvested once a year, but may be consumed daily throughout the year. The consumer does not buy a year's supply at harvest time nor can the farmer supply the consumer daily. Wheat is stored in a granary on the farm, in the local elevator, or in the terminal elevator waiting to be milled into flour, stored as flour, and finally baked into bread for the consumer. Storing is an important factor.

Assembling and Financing. Farm products must be bought and sold in the process of marketing to make possible the assembling of volumes large enough to make up carloads or shiploads for efficient and economic transportation; to fill large elevators in quantities large enough to make storage cost less; to permit the operation of large mills or processing plants at low cost. Buyers make it possible for a farmer to sell his crop whenever he wishes, relieving him of the details of finding a consumer. They make a ready market possible. Buyers, in turn, sell, carrying the product through various processes toward the final consumer. The advertisements of sellers create demand by attracting new buyers and thus make it possible to sell more or to sell at a higher price. Buying farm products requires large sums of money which someone must furnish for periods of time necessary for transporting, storing, processing, and distributing. Financing marketing is, therefore, a necessary service. Risk of loss from fire and deterioration and decline in price during the processing also must be assumed.

Standardization. Standardization is necessary in the process of marketing to insure a uniform and dependable quality that permits purchase and sale on description by letter service, thus making personal inspection less necessary. Sorting and grading of raw products begin at the farm. State and Federal grades and standards are established and enforced by State and Federal inspection. State grades and standards apply particularly within the state while Federal grades apply to trade among states.

Packaging. Farm products finally reach the consumer in some sort of package that the consumer prefers with respect to volume, quality, grade of product, appearance, preservation of content, and price. A trade-mark and description identify the contents and give the consumer confidence in buying, if he believes he is getting dependable quality.

Distribution. Distribution refers to the processes involved in getting the finished product from the processor to the consumer. It involves wholesalers who buy large quantities for the processor, resell to jobbers, or direct to retailers.

Summary. Marketing functions may be grouped in summary roughly, (1) as those having to do with exchange, that is, buying and selling and creating demand; (2) those affecting physical supply, as transportation, storing, and processing; and (3) those that facilitate or make easier the process of marketing, as financing, risk-taking, and standardization. These functions, efficiently performed, add utility and value to the farmer's product on its way to the consumer. The cost of such functions is included in the price the consumer pays at retail.

MARKETING COSTS

The farmer is interested in the difference, or spread, between the price he receives for his product and the price the consumer pays for the finished product at retail. He sometimes feels that he is not getting a fair share of the consumer's dollar. A number of years ago, a popular farm magazine expressed the idea in a cartoon entitled, "What happens in the dark," the dark being represented by a black area between the producer and the consumer. Another phase of the same problem is, "Who gets the consumer's dollar?" According to the Bureau of Agricultural Economics, U. S. D. A.,* the farmer's share of the consumer's dollar, spent for 58 foods during the period 1935-39, was 42c. The balance, or 58c, went to pay for the functions of marketing that operate between the farmer and the retailer's shelf or the consumer. The payment for these services makes up what may be termed the "cost of marketing," or "marketing margins."

All farm products require some of the marketing services, but there is a wide difference among the various products he produces. Eggs and potatoes do not require processing and reach the consumer in the same form in which they left the farm. Hogs, on the other hand, must be slaughtered and cut up into consumer-size packages, some parts cured or smoked or ground into pork sausage. Wheat must be milled into flour, mixed with other ingredients into dough, and baked. The more processes the farmer's product necessitates, the more hands it passes, the higher are the marketing costs and the smaller the farmer's share of the consumer's dollar. The efficiency with which products are handled in the marketing process is an important factor in determining marketing costs. The marketing cost may be regarded as a measure of that efficiency as well as the necessary services that need to be rendered. The farmer gets only 12c* out of a dollar spent for soda crackers, but he gets 82c out of a dollar spent by the consumer for pork products. He would like to get a larger share, but he must remember that he can not perform all the marketing functions, because he is busy producing the raw materials and depends on others to perform the necessary functions for him. When he sells his milk, fruit, vegetables, and poultry products direct to the consumer at his farm or delivered at the consumer's door in the village, he gets the consumer's whole dollar. He has performed the necessary functions of sorting, grading, packaging, and transportation himself and is paid for the time required. Obviously he can not market all his products direct and must depend on others and pay them for the services they render. His problem is to find or develop a system of marketing that will sell his products most efficiently by finding the market paying the highest price per unit, according to accurate grade and function, at the lowest possible cost to reflect to him the highest net income. He must expect to pay enough for such services to enable middlemen to stay in business, but he should not have to pay more than cost of operation plus a reasonable margin of profit to provide for safe reserves. He needs to study marketing as thoroughly as he studies the production of his products, in order that he may be able to judge a marketing agency intelligently in making his choice of the most advantageous market, viewed from the standpoint of convenience, economy, and general satisfaction.

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* Farm Retail Price Spreads, March, 1942, B. A. E., U. S. D. A.

FARMERS' MARKETING PROBLEMS

The farmer faces some problems that are peculiar to the marketing of farm products. To begin with, the average farm is a relatively small-producing unit. There are over six million farms in the United States reported in the 1940 Federal census. The quantity produced on any one of them is a very small part of the total produced, and hence is comparatively insignificant in the total supply of goods offered for sale. Each farmer tends to sell his own product and sells in competition with all the other producers of the same product. Having only a small volume to sell, he has little power to bargain and must accept the price offered. His main protection is knowing what the price should be on the market where he has to sell. Since production comes from many small independent units, the products are not uniform and hence are difficult to standardize for sale in large volumes. Potato farmers may have difficulty in putting up a uniform carload of potatoes, unless they produce large acreages. They must depend on others to assemble small lots to satisfy a larger market demand.

Production Control Difficult. Farm products are the result of life and growth, and hence are subject to variations in climate and conditions necessary for such growth and production. It is, therefore, difficult to control production, since the conditions of that production are largely beyond the farmer's control. When the farmer plants his crop, he depends on rain and temperature necessary for its growth. Although he had chosen a farm with soil and usual or normal climate favorable to the crops he wished to grow, no climate is entirely dependable or free from devastating storm, frost, disease, etc. He can not halt production even though price conditions may not enable him to cover costs. He must go through with his planned production to avoid total loss. He can not control the cost of production by discharging labor, since he and his family still furnish a substantial part of the labor necessary and he and his family must live. He can not insure desirable quality of his products, since quality depends on favorable growing conditions. He can attain quality only by sorting and selection. Insect pests and diseases attack his crops and livestock and, in spite of best care and attention, they can not be entirely controlled. His livestock production depends on

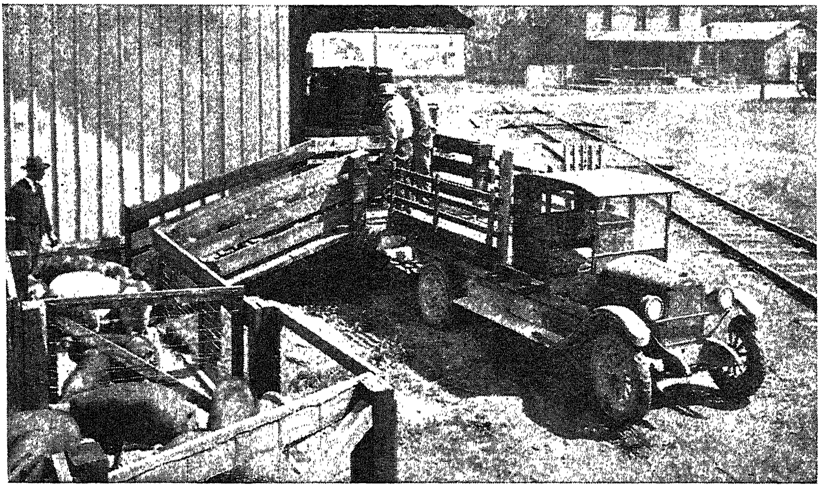

Figure 19. Transportation by truck. A trucker delivering a load of hogs at a local market.

crops produced for feed. The farmer thus has difficulty in producing a uniform supply of uniform quality.

Transportation Necessary. The farmer is a long distance from the consumer of many of his products. Physical distance may not be greater than that of the producer of manufactured goods from his consumer, but economic distance may be greater in relation to processing and storing. Farm products must pass through more hands on their way to the consumer and, therefore, the smaller share of the consumer's dollar comes to the farmer. Direct marketing of some products is impossible.

Farmers Bear the Cost. Marketing costs are included in the price the consumer pays for the farmer's product and are deducted from the consumer's price, the balance going to the farmer as the farm price for his product. In this sense, the farmer is a residual claimant of the price paid by the consumer. The farmer does not always understand why marketing costs are so high and why the consumer pays so much more for the product than the farmer receives. He does not always appreciate the services that are rendered by these marketing functions. Advantage, at times, has been taken of farmers in assessing charges for these services. As a consequence, farmers have developed an interest in doing their own marketing through co-operative action in carrying their products to the terminal markets and in some cases through to consumers.

CO-OPERATIVE MARKETING

During the past quarter of a century farmers' co-operative marketing agencies have increased rapidly. Beginning with the more simple functions of assembling and shipping, activities have spread to include many of the functions required in getting farm products clear through to consumers. Where soundly organized and well-managed co-operatives have succeeded in reducing the costs of marketing, they have increased the net income to farmers from products sold. Co-operative agricultural marketing organizations in many instances have forced private marketing agencies to improve their facilities and pay better prices for farm products. Those engaged in farming should give careful study to the advantages offered through co-operative marketing organizations.

The Objective of Co-operation. Webster defines co-operation in economic life as "the association of a number of persons for their common benefit; collective action in pursuit of common well-being, especially in some industrial or business process." In marketing farm products, co-operation is the working together of a number of farmers in performing some function or functions of marketing as a common problem to the financial advantage of each member of the group. The objective of co-operation by any group is to do together what they could not do as well as individuals. The objective of co-operation in marketing farm products is to perform the functions of marketing more efficiently and to reflect the savings made to the co-operating farmers in a higher net price at the farm. It is aimed at reducing inefficiency in the marketing of farm products. There must be an opportunity to render new or better service than is otherwise available and that will reflect a higher price to the farmer without necessarily raising the retail price to the consumers. In modern business everyone is interested in his own financial welfare and anything that contributes to an increase in his income. The farmer is no exception. He will do what he can to increase his income by more efficient marketing of his products even if he must set up his own marketing agencies when savings can be effected by so doing.

Functions of Agricultural Co-operatives. A co-operative is a business organization set up to do a specific job of selling or buying. It is owned and operated by its members. Each member has one vote. It is controlled democratically, since each member has a voice in its operation. Any producer of products handled by the co-operative may become a member by buying a share of stock or paying the required membership fee. It assembles products of individual farmers and sells the combined volume of products in a market that may not be accessible to an individual farmer. It is assured of an initial dependable volume of business made up of the combined production of its members and patrons. It aims to maintain and increase that volume by efficient operation and resulting ability to pay a price as high or higher than that paid by less efficient operators with less volume. It gives each member the advantage of the bargaining power of the combined volume. The large volume attracts buyers and gives the farmer access to larger and more distant markets where more buyers are bidding. Profits or savings are paid back to the farmer in patronage dividends based on the volume of business done with it by each member or patron. Since each member has a voice in its operation, he feels that he has an active interest in it, that it is operating for his benefit, and that he gets the full market price for his products less the actual cost of operation and the reserves that need to be set aside to assure a stable financial condition. He has a share in the reserves and net worth of the organization in proportion to his contribution in the volume of business and shares bought. In short, he can feel that he has a marketing organization working for him which not only makes it easier for him to sell his products but assures him a fair price for them. Creameries, elevators, livestock shipping associations, cotton gins, egg and poultry associations, and tobacco associations are examples of local co-operatives.

Local co-operatives can, in turn, organize regional co-operatives to extend marketing functions even to the consumer. If it is an advantage for farmers to co-operate locally, it is just as reasonable to expect an advantage for co-operatives to federate. Such federations serve as wholesalers or commission companies, having the advantage of assured volume and greater economic possibilities. Thus they centralize selling and buying to increase bargaining power. Any savings are refunded to the individual farmer through his local co-operative.

Land O'Lakes Creameries is a nationally known example of such federation.

Co-operative Setup. An agricultural co-operative may be organized by a group of farmers interested in marketing a certain farm product or related farm products after they have satisfied themselves by a study of their community that such an organization is needed. Perhaps there is no local market for a particular product or such a market does not pay a satisfactory price. They have satisfied themselves that there is sufficient volume available to insure successful operation, based on the number of cows, the amount of milk produced, the number of livestock marketed, or the acres of crops produced. They are satisfied that enough farmers will join the organization. A meeting of all interested is called to discuss the matter. A vote is taken to proceed with the organization. A committee is appointed to prepare the plans under which the organization will be set up (articles of incorporation) and rules for the detailed operation of the organization (bylaws), checking them with the Attorney General's office where State laws require it. An estimate is made of the amount of money needed to build a plant or to operate it, and the value of shares to be sold to members to provide the needed capital. The purpose and operation of the association is explained, that the members may be thoroughly informed. When sufficient stock has been sold, an organization meeting of stockholders is called to perfect the organization and approve the articles of incorporation and by-laws. A board of directors is elected which later organizes by electing a president, vice-president, and secretary-treasurer. The articles of incorporation are signed by the directors as incorporators and filed with the Secretary of State. Legal incorporation is essential to give the association legal standing and to protect the members. The board of directors formulates the policies of operation and hires a manager to operate the business according to those policies. The association is then ready to proceed with putting the organization into operation.

Difference Between a Co-operative and a Corporation. An Agricultural Co-operative differs from a Corporation in a number of ways. The most important of these are shown in the following comparisons. Either one must be organized within the laws of the state in which it operates.

An Agricultural Co-operative	**A Corporation**
1. Membership open to producers of farm products upon approval of Board of Directors.	1. Membership open to investors without production but may be limited.
2. Each member has one vote regardless of number of shares owned.	2. Each share of stock carries a vote regardless of the number of members.
3. The individual member is the unit of voting power.	3. The share of stock is the unit of voting power.
4. Voting by proxy not permitted.	4. Voting by proxy is legal and commonly practiced.
5. Dividends on stock limited to normal rate on money in general use.	5. Earnings on investment stock are unlimited and may be paid as dividends.
6. Earnings above interest on stock are paid out in proportion to volume of product furnished by each patron.[*]	6. No provision for patronage dividends.
7. The rights of the individual member receive supreme consideration.	7. Rights are based on the amount of money invested.

Legal Requirements of a Co-operative. Each state has its own laws relating to co-operatives within its borders. The general requirements are summed up in what is known as the Rockdale[†] principles of co-operatives which, applied to marketing co-operatives, are essentially as follows:

1. A co-operative is primarily a business enterprise. A creamery may be a co-operative—a church is not.
2. Voluntary membership.

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[*] Nonmembers selling through a co-operative are entitled to patronage dividends but have no voting power.

[†] Abstract of the Laws Pertaining to Co-operatives in the U. S. and its Possessions and Territories, U. P. A., City of New York.

3. Democratic control, that is, one man and one vote with no "proxy voting."
4. Distribution of savings or reserves in direct proportion to participation of member.
5. Fixed rate of interest on capital or shares of stock.
6. Religious and political neutrality.

These principles with some additions are stated in the Capper-Volstad law governing agricultural co-operatives in the United States. They are as follows:

1. A co-operative must have for its purpose the mutual benefit of its members.
2. Each member has but one vote regardless of the number of shares of stock he owns.
3. Dividends or interest or stock must not exceed 8 per cent per year. Surplus reserves distributed on basis of patronage.
4. More than 50 per cent of the total volume of business must be done with members of the co-operative.
5. Substantially all the members must be farmers.

Financing a Co-operative. A co-operative marketing organization secures the necessary capital for building, equipment, and operation through the sale of stock or memberships with voting power in the form of common stock to members. This is sometimes supplemented by the sale of investment stock, called preferred stock, to members who wish to invest money for the interest earned and to help finance the co-operative because of local interest and, when necessary, by loans from local banks, individuals, or the Bank for Co-operatives. If a co-operative, such as a livestock shipping association, does not need capital for operation, a nominal membership fee is paid as an evidence of interest and good will. Usually such associations are rather loosely organized.

Prospective members should be thoroughly informed as to the purposes, the advantages, and the possible difficulties of the co-operative when they are being solicited for purchase of stock, in order that they may have a clear understanding of the association and the need for it as well as of the possible benefit to themselves. Co-operatives should not be oversold by extravagant promises. They should be sold on the basis of needed sound business organization and the essentials necessary to make them successful. The capital should be subscribed by many different members to insure the largest volume of business.

Purchase of a share of stock by a farmer gives him a financial stake and interest in the undertaking. If farmers are not willing to buy stock in a co-operative, it suggests that they do not recognize the need of such an association or do not understand its possibilities. Purchase of stock is evidence of the farmer's interest and sense of need, and should be regarded as an investment in a useful agency. Few co-operatives start with all the necessary capital subscribed by its members. Money needed for the balance must be borrowed from banks or individuals. Frequently too little stock is sold and too much money is borrowed. Reasonable plans for repayment of loans should be worked out and put into effect as soon as possible.

Directors' Responsibilities. The board of directors of a co-operative is elected by the members at the annual meeting. It is the board's duty to direct its operation for the benefit and service of the members. The number of directors is preferably odd to avoid tie votes, but not so large as to be unwieldy. Each director should be chosen for his ability to help the co-operative operate more effectively. Business ability, honesty, and sincere interest in the job to be done are most important. Willingness to serve, while valuable, is not as important as good business ability. It must be remembered that deciding the policies or plans for operating the co-operative for the benefit of the members is the function of the board of directors. Without a capable board, the co-operative may be expected to run into difficulties. The members have a right to expect the board of directors to assume major responsibility. Often too little thought is given to the selection of directors.

The board of directors usually meets soon after an annual meeting to organize by electing officers and appointing committees. The same person may be secretary and treasurer, if the constitution so provides. The board of directors should meet regularly, at least monthly or as often as may be necessary to keep in touch with the operation of the co-operative. It is the duty of the directors: 1. to determine the price per unit to be paid to patrons, as in creameries; 2. to review the financial and operating statements; 3. to examine accounts receivable; 4. to study reports of operations to familiarize themselves directly with the business.

In addition to attending meetings regularly, the directors should study the problems of their co-operative, in order that they not only keep up with developments in the marketing of their particular commodity but become able to anticipate probable changes and so insure an effective business unit.

Members of the board should be spread over the area served by the co-operative in order that the members or patrons of each section may be represented. Such distribution makes it easier for members to talk over individual producer problems with a board member whom they know. The directors have a responsibility, too, for keeping the members informed as to the operations of the co-operative. Members should feel free to go to a director with questions or dissatisfactions and for information and explanation.

The directors have the power to select and hire a manager and other employees to carry out the policies of the board. If the board is composed of capable men, they are likely to select a capable manager. The board can not shift all responsibility of operation to the manager, however. They must supervise and work with their manager in the actual operation of the co-operative and keep well informed about its operation.

Members' Responsibilities. Members have not discharged all their responsibilities to the co-operative when they invest money in shares of stock. They should understand why they will benefit and why they should deliver products to be sold by the co-operative over a period of time. They may not always be satisfied but they have confidence that their co-operative will reflect the full market value less actual marketing cost and the necessary deductions for a sound reserve with which to operate. If not satisfied, they should use their right as members to go to a director or manager for an explanation. They should not stop patronizing the co-operative because of some dissatisfaction but should aim to correct and improve any fault by working through the directors or manager. Too many members think too much in terms of what price they get without considering what price they would receive if the co-operative was not in the field. Members should attend annual meetings regularly, in order that they may find out about the operation of their organization and make suggestions for its improvement. Too frequently a co-operative must furnish a free lunch to attract sufficient attendance to make a legal meeting possible. The members must think of the co-operative as belonging to them and recognize the part they must perform, if it is to be successful. The literal definition of a co-operative, as "working together," must be taken seriously with emphasis on working. Finally, there must be enough members and patrons to deliver a large enough volume on which the co-operative can depend to make it possible to operate at a low per unit cost. A creamery can manufacture butter at less cost if it handles 1,000,000 pounds of butter rather than only 100,000 pounds, because fixed costs, such as depreciation on buildings and equipment, are divided over a larger volume of product.

Responsibilities of the Manager. The duty of the manager is to operate the business of the co-operative under the direction of the board of directors. He is hired because of his ability and experience in conducting the business of marketing a given product or products successfully. To do so he must know where he can sell at the highest prices and with the least cost or expense, so as to be able to pay the producer the highest possible net returns. He must recognize quality in the product as the farmer delivers it, in order that he can pay a price in line with the quality. He must be able to gain the confidence and good will of his patrons. He must be a leader in the organization, suggesting improvements in operation, and submitting suggestions to the board of directors for decision, if it involves a question of policy or the expenditure of money. He makes decisions in keeping with the general policy. The manager comes in close contact with members and patrons and hence can do much to keep them informed, especially on details of operation having to do with the product handled, with regard to grade and quality. He can answer many questions that patrons may raise and so contribute much to keeping the members informed. In short, the manager, with the directors, must so operate the co-operative as to be able to pay sufficiently high prices to meet competition and pay dividends on savings or patronage as concrete evidence of efficient operation.

Co-operative Education. Co-operatives can help develop a sense of unity among their members by holding meetings the purpose of which is to acquaint members with the business of their co-operative as well as about problems involved in the marketing of a given product. Co-operative creameries can do much to improve the quality of the finished product by demonstrating to their members how to produce higher-quality milk and cream. Quality production will be further encouraged by returning a price for such quality as will pay any added costs and some profit. Members can learn about the principles of co-operation in meetings arranged by the co-operative. By understanding the principles they will be better able to practice co-operation.

Democratic Procedure Required. To be truly co-operative, an organization must be democratic in its operation. One member and one vote assure government by the members, provided each exercises his right as a voting member. Members must be free to express criticism as well as approval at annual meetings. Election of officers should be well considered, unbiased, and free from prejudice. Questions regarding the co-operative should be encouraged and answered honestly, if confidence is to be maintained. Nominations for directors are more representative of the wishes of the members if made by secret informal ballots. If three directors are to be elected, each member may write on a nominating ballot the names of three members he favors. The informal ballots are then counted and the six (two nominations for each vacancy) names receiving the largest number of votes are considered nominated. Formal election of three directors by secret ballot should follow. This method insures more careful selection of prospective directors without embarrassment or the attributing of too much weight to an aggressive nomination. By taking active interest and part in the functioning of a co-operative, the members gain understanding of their responsibility to larger democracies such as county, state, and national government. A good co-operator is usually a good citizen.

Essentials of Co-operation. The essentials of co-operation can be grouped or summarized under five main heads, namely:

1. Economic need or opportunity to save the farmers money in marketing their products.
2. Loyal and understanding support by members.
3. Enough capital subscribed by members which, together with sound loans, will insure enough money to carry on the business effectively.
4. Efficient operation by a capable manager working with a carefully selected board of directors.
5. An accurate record of all transactions, with audits at regular periods by a disinterested trained auditor.

MARKETING GRAIN

Having produced a crop of wheat, oats, barley, flax, corn, peanuts, or soybeans, the farmer must answer the questions when, where, and how he can best sell his grain and convert it into cash. He would like to sell when the price is the highest, but he may have borrowed money which he promised to repay "when the grain is threshed." He may, therefore, be forced to sell at the same time many others are selling, when the crop will be coming to market faster than it is being used and prices are likely to go down. Wheat often sells for more in the spring than at threshing time, but the difference in price is seldom more than enough to pay for storage, handling, interest on the money invested, insurance against loss by fire, and storm risk.

Grains are usually sold to a local grain elevator, privately or co-operatively owned, that offers the highest price. The farmer watches the local newspapers for price quotations and telephones various elevators for the market price of that day. He delivers his grain at the elevator where it is weighed and samples are taken from different bags or parts of the load to get a true test of the quality of the load. A test scale is used to determine the weight of a measured bushel, as the weight of the grain is a test of its quality. A given weight of grain is then put through a cleaner or "kicker" that separates the clean grain from the dirt and weed seeds, and the percentage of dockage is determined. Early in the marketing season a test is also made of the moisture content to determine excess moisture as a deduction from price or to see how well the grain will store. These tests are made to determine the number of bushels of clean grain in the load, and its quality as a basis for the price to pay per bushel.

If prospects are good for a higher price later, a farmer may decide to store his grain in a local elevator, paying the usual charge per bushel per month. He receives for it a storage ticket stating the grade and amount. His grain is mixed in the elevator with grain of the same grade and he may claim the same number of bushels of the same kind of grain when he desires to sell.

The elevator can not store all the grain it buys for storage and in turn sells to someone who stores the grain in a terminal or large market center elevator. Grain may be stored at the terminal also at a given rate of storage per bushel. From elevators, local and terminal, the grain is sold to mills that grind the wheat and rye into flour to be sold to consumers to be made into bread.

The local elevator serving the farmer may be owned by an individual, by a terminal elevator, or a grain company operating a line of local elevators, or it may be co-operatively owned by the farmers who patronize it. An individual or a co-operative elevator depends on some commission company at the terminal market to sell the grain for it on what is called "the grain exchange." At this "exchange," samples of grain are taken from cars by licensed samplers and displayed to show the quality of grain in the car. Millers and grain dealers buy the cars of grain at the exchange on the basis of the samples.

"Futures" on grain are bought and sold in this exchange.

Futures are contracts to accept or deliver grain at some time in the future. They are used by speculators who aim to buy low and sell high, making money from changes in price. Futures are used by legitimate dealers who protect or hedge their purchase or sale by a corresponding sale or purchase. An elevator manager who buys a load of wheat sells a corresponding number of bushels for delivery at some future time, thereby protecting himself from a decline in price. The operation of "future markets" makes it possible to shift the risk of price changes to speculators and tends to stabilize market or daily prices.

Co-operative elevators may join together to operate their own terminal elevator, with the view of extending the market to the consumer. The co-operative terminal thus represents the local co-operative in the sale of grains in the interest of the member of the co-operative. Such local and terminal co-operative elevators give competition to privately-owned concerns and tend to narrow the margins charged for marketing service. Through this grain-marketing organization a farmer can sell a large or small lot of grain to reach the market whenever the grain is needed.

MARKETING FARM LIVESTOCK

Livestock may be sold to a local butcher who slaughters it and sells it over the counter to his cutomers. The butcher performs all the functions of marketing and gets the entire margin between what he pays the farmer and what he receives from his customers. Only a very small proportion of the farmer's livestock is sold in that way. Most of it must go to small packing houses located where a lot of livestock is produced or to packing plants at large central terminal livestock markets.

Shipping Associations. Before the development of hard-surfaced roads and trucks, farmers had to depend on railroads to get their livestock to the market. Very few farmers had enough livestock to fill a stock car and had to sell to local buyers who assembled the stock into car lots for shipment to market, frequently taking advantage of the farmer by not paying full local value. To overcome this disadvantage farmers organized co-operative livestock shipping associations to assemble and ship livestock in carload lots. Each farmer's stock is "branded" with paint or "clipped" marks and sold separately at the market. This gives the individual farmer access to the terminal market. Shipping days are advertised and farmers bring in their livestock to be weighed, branded, listed, loaded, and shipped by the manager to some commission company or the terminal market to be sold to packers, feeders, or others. Each farmer's livestock is sold separately and a complete itemized account of sales is sent back to the manager with a check for the total shipment, less expenses incurred, such as freight, yardage, feed, insurance, commission charges, etc. From the account sales the manager can tell each shipper the sum at which his stock sold. Local expenses for managers' commission, lumber, nails, rope, feed, hay and a deduction for a reserve or sinking fund are added to the terminal expense and prorated on the basis of live-weight, thus allocating the expense equitably to each shipper.

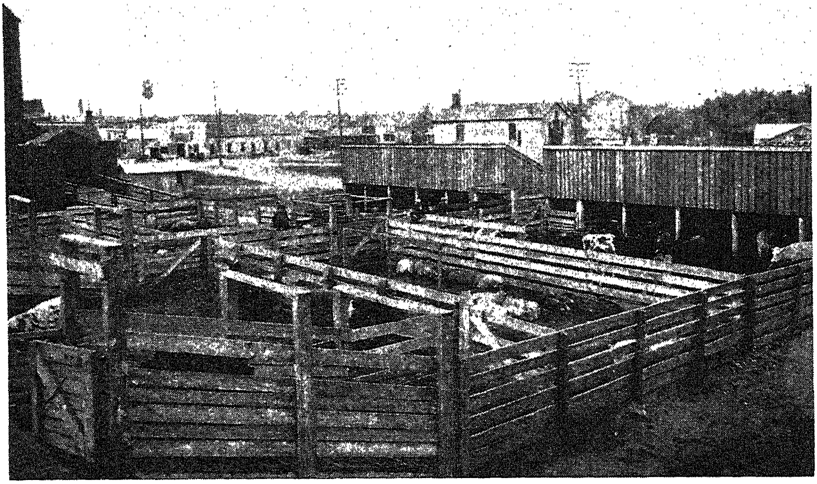

Figure 20. Assembly yards of a co-operative livestock shipping association where stock is marked for identification and grouped into car lots for shipments.

Terminal co-operative commission companies are organized at most terminal markets to handle the shipments from local shipping associations, enabling individual shippers to make savings on commission charges. By handling a larger volume of business it is possible to attract more buyers and perhaps get a somewhat higher price for their patrons. The savings or commissions are prorated back through the local association to the individual shippers.

Trucking to Market. With the construction of hard roads and the general use of trucks, farmers no longer need to ship by rail carload lots, and hence need not feel the urgent need of shipping associations. With the coming of the truck, farmers can now haul their own livestock to market in their own trucks or telephone a local trucker to pick up a calf or a truckload of stock and take it to market. Farmers depend on truckers not only to transport livestock but also to sell it. As a result, shipping associations have declined in numbers and in volume of livestock handled and farmers are drifting back to greater dependence on local buyers and truckers, and losing control of their local marketing association and weakening their terminal commission company by lack of support.

Direct Buying. The development of livestock trucking was accompanied by the practice of marketing livestock direct at feed lots to packers without going through the terminal markets. The location of "interior" packing plants in areas of dense livestock population, particularly hogs, encouraged this practice. Some marketing services rendered at terminal markets can be saved by selling direct, and hence there is a smaller marketing margin to deduct from the market price in arriving at the price paid the farmer. Livestock produced near a packing plant does not need to be hauled as far as would be necessary if all livestock went to the terminal market to be sold and shipped out to packers. Commissions on sales, yardage, and feed are eliminated in direct marketing. On the other hand, the question remains to be answered whether the complete services at the terminal market and keener competition may not secure a higher market price and, hence, even after all deductions are paid, reflect a higher net price to the farmer. By selling his livestock direct, the farmer loses the advantage of the bargaining power of larger volume handled by a shipping association or a co-operative commission company. He could retain such advantage, however, by selling through a co-operative agency that has bargaining power and ships direct to the packer, saving on a shorter haul, yardage, and feed.

Concentration Yards. Co-operative concentration yards as livestock marketing agencies are in operation in some states. They employ a trained manager who can afford to keep in touch with the various markets, can interpret quoted prices, and identify market grades. He represents the farmer and serves him as a market adviser on when and where to sell, and as to price to expect. The large volume necessary to make a living for a full-time manager may permit sorting and grading of hogs into car or truck lots and selling "on order" or over the telephone, saving some selling expense thereby.

Direct marketing of livestock is here to stay and farmers and their co-operative livestock marketing agencies must adapt themselves to this situation, taking advantage of all possible economies but maintaining the bargaining power necessary to insure them a fair market price for their livestock.

The buyers and sellers on the provision market determine the prices to be paid for food as a finished product. The price of meat on this market is the basis for market price of the raw materials, hogs, cattle, and sheep, from which meat products are processed. The price of meats ready for the retailer is an important factor in determining what the price of the live animals shall be, together with the number of animals actually on the market, or ready for market, and the number and eagerness of buyers bidding for such numbers. Thus the wants of the consumer for meat with the necessary purchasing power are reflected through the retailer, the wholesaler, to the packer and finally to the farmer and his livestock.

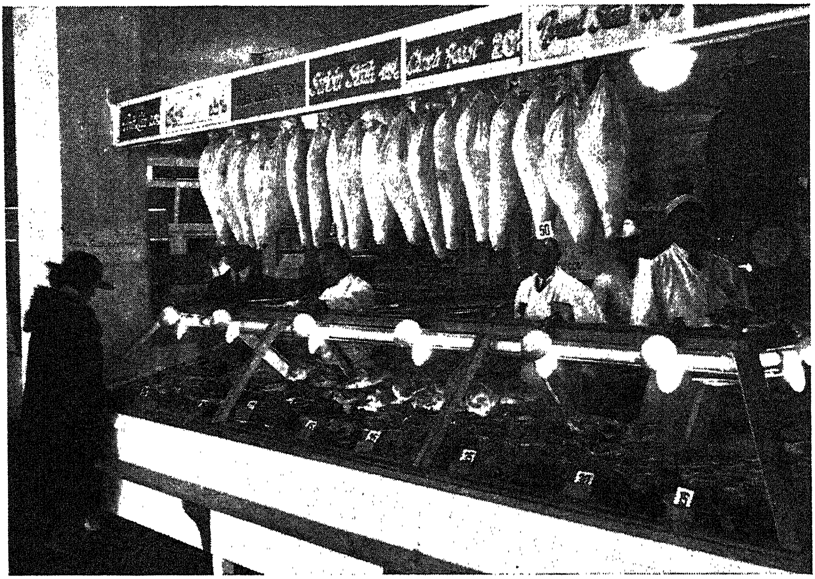

Figure 21. A display of meats processed into attractive forms for consumers.

MARKETING DAIRY PRODUCTS

Milk is marketed as liquid milk, raw or pasteurized or manufactured into a variety of products, such as butter, cheese, evaporated or condensed milk, dry milk powder, and casein. The process of marketing may be simple, as when a dairy farmer bottles the milk and delivers it himself to the consumer that comes to his farm or who lives in the nearby village or city. In that case, he performs all marketing services and receives all the money paid by the consumer. But only a small proportion of milk is marketed so directly. Near the larger cities the farmers sell their milk to a milk-distributing plant that standardizes, pasteurizes, and bottles the milk and delivers it to the consumer on regularly supplied routes. There may be more milk distributors selling milk in that way in some localities than is necessary to serve the consumers adequately, with the result that the cost of distribution is unnecessarily high.

In still larger urban areas, the farmers may sell their milk through a co-operative bargaining association. This association represents its farmer-members in the area in dealing with the milk distributing companies that actually deliver the milk. Such an association enables the farmers to bargain with the distributors more effectively as to price. Such a bargaining association may not be able to sell all its milk as whole milk and manufactures the balance into products, such as butter, cheese, or condensed milk, that will pay the best price for milk to the individual farmer.

The price paid for milk is determined on the basis of butterfat content in the milk, since butterfat is perhaps the most important single milk product. Milk solids can be expected to receive more consideration than in the past because of their now recognized nutritive value. The price paid for butterfat sold in whole milk tends to be higher by the added value of the milk solids and the extra cost incurred in maintaining high quality. Competition from farmers outside ready to sell whole milk tends to keep whole milk prices in line.

Butter Marketing. About one half of the milk produced in the United States is manufactured into butter. Most of this milk is separated and the cream delivered to local creameries to be made into butter. In some states, about three fourths of the butter manufactured comes from co-operative creameries. Farmers used to deliver whole milk to be separated at the creamery. Now home cream separators are used and the skimmilk is fed to hogs, calves, and chickens, at a saving of some hauling. The cream is delivered at the creamery by farmers or picked up by trucks on regular routes, the cost of hauling being paid by the farmer. With the increased use of skimmilk in the manufacture of human foods, more whole milk is sold from farms.

Farmers originally sold their dairy products as butter, churned on the farms. It was sold at local stores and resold to patrons of the stores. Its quality varied widely and the price was fixed largely by the value of the low-quality butter. With the coming of creameries, and especially the co-operative creameries, the butter is manufactured by trained buttermakers in large enough quantities to be shipped to larger markets. It commands a higher price because of its uniformly higher quality. This higher price stimulates dairy production. Paying more for sweet cream encourages taking better care of the cream and results in further improvement in quality and a higher price. The co-operative creameries can claim no small share of credit for the development of the present dairy industry.

Co-operative Creameries. The Co-operative creameries have the usual co-operative setup, but require more capital, because their operations involve the use of a building and necessary equipment. Hence shares of stock must be sold and an association organized. The board of directors hires a trained operator who may also act as manager. The member patrons deliver their milk or cream regularly as often as is necessary to insure good quality. The milk or cream is weighed, and a sample is taken to be tested for percentage of butterfat, and the weight of cream or milk is recorded for each delivery. Payment may be made for each lot on the basis of the butterfat test, but more frequently payment is made at the end of the month at a price determined by the board of directors and operator-manager and is based on sales made. The samples of milk taken are saved by use of a preservative and the composite samples tested at the middle and end of each month. The total weight multiplied by the average or composite percentage of butterfat gives the total amount of butterfat delivered that month. The number of pounds of butterfat multiplied by the average price of butterfat gives the total payment to the farmer. The price of butterfat is based on the price of 92-score butter at New York. Surplus income in excess of necessary operating costs and reserves may be prorated as a patronage dividend to the patrons at the end of the year. The farmer thus receives the full market value of his product, less actual cost of manufacturing and operation and deduction for reserves.

Local creameries depend on butter brokers or commissionmen in more distant consumer markets to find an outlet for their product. A charge is made for finding a market. Chain stores serve as outlets for butter through the stores in their system. One agency buys the butter for the entire chain from individual creameries, eliminating some handling charges and tending to shorten the way from the producer to the consumer, by narrowing the marketing margin of costs between them.

Some co-operative creameries have organized selling agencies of their own to represent them in distant markets. Land O' Lakes Creameries, Inc., is an example of such an organization. This organization sells not only butter and other dairy products for its member creameries but poultry and poultry products. Creamery and farm supplies are also handled. By placing emphasis on quality it has succeeded in improving the quality of the products handled. By an extensive advertising program, it has made sweet-cream butter popular enough to increase the demand for it at a higher price.

Other Forms of Sale. Ice cream factories offer a special market for high-quality dairy products either locally or in large consumer centers. Cheese factories are markets for whole milk but are of relatively minor importance, since cheese is not a large item in the national diet. Fresh, clean milk is necessary in making a high-quality cheese. A strong demand for butter has discouraged the expansion of cheese manufacture. An increasing volume of condensed and evaporated milk is required for use in the manufacture of candy and confections. The use of dried milk, either whole or skimmed, has increased very rapidly as a result of the present war because of ease of storage and transportation for export to the United Nations. Its domestic use is limited as yet but has definite possibilities of expansion when it is put up in consumer-size packages. In this form, it may become a definite competitor of whole milk.

MARKETING POULTRY PRODUCTS

Poultry products, particularly eggs, require relatively little or no processing beyond that necessary to maintain the original quality of the products. Eggs deteriorate rapidly unless carefully handled. Heat encourages incubation and hastens the breaking down of the contents of the egg. Emphasis is placed by the consumer on fresh eggs. To preserve their freshness, eggs should be gathered several times a day especially during the heat of summer and placed in a cool and fairly dry place away from objectionable odors. Care of eggs begins at the farm and must be followed rigorously until they reach the consumer to maintain the quality that commands a fair price. They should be graded as to quality, size, and color of shell, in order to supply the buyers or consumers with an attractive quality for which they are willing to pay a good price.

Most farm eggs are first sold locally to a store, produce house, or poultry co-operative. Some creameries handle eggs as a side line. They may be candled to determine the condition of the contents of the egg and graded. Sometimes they are sold "case-run" and are candled and graded later. Since eggs may vary widely as to size and quality, the farmer should be paid on a grade basis to encourage the production and marketing of eggs of high quality. Artificial refrigeration should be provided constantly to preserve the original quality at all stages of the process of marketing.

From the local market, eggs move to large centers where they are handled by brokers, commissionmen, or at egg auctions to be sold to distributors as fresh eggs. They move by refrigerated transport, either express, fast freight, or transport trucks, in order that the least time possible be spent in transit. Egg auctions are operated in some of the larger consuming centers where lots of eggs are sold to the highest bidder. Shipments of eggs are recognized and identified with quality or the lack of it, and bids are made accordingly. Some auctions operate on a co-operative basis and represent the producer's or shipper's interest in a co-operative.

Co-operative Egg Markets. Some large egg and poultry marketing associations have been organized in areas where poultry production is an important enterprise. They are composed of local co-operatives that assemble eggs locally, ship to the central organization where eggs are more carefully candled and graded, and finally sent to large consumer centers to be distributed to the consumers. These central marketing associations have been able to overcome the disadvantage of distance from the market by efficient operation and, by putting out carefully graded and standardized eggs, they are able to compete successfully with producers and agencies more favorably located.

Egg Storage. Eggs are produced seasonally. More are produced during the spring and early summer. Production is becoming more uniform, however, as more emphasis is placed on commercial production. Eggs, nevertheless, must still be stored from periods of heavy production for sale during periods of low production. Eggs are put into storage in largest numbers during the spring months. Storage facilities generally are well filled by August 1. Use of the stored eggs begins in late August, and continues on through the fall and winter. By March 1, the low point in numbers of stored eggs is reached.

Storage is an important marketing function and tends to stabilize prices. Without it, eggs would be still lower in spring and early summer, and still higher in the fall and winter. To facilitate marketing and storage, eggs are broken and the contents frozen in cans in increasing quantities. In this form they take up less space and result in less loss through breakage, evaporation, and general deterioration and are more convenient to use in baking and similar use. Egg powder, made by drying or dehydrating, is becoming increasingly important. Special impetus has been given this practice by the present war. A skillful cook can use egg powder successfully in place of eggs, except in serving poached or boiled eggs. Increased domestic use of egg powder after the war is probable.

Poultry Meat. Poultry takes the form of meat on the consumer's table. It consists of the various forms of fowl, such as chickens, ducks, geese, and turkeys. It follows the same general marketing processes as eggs. The farmer may sell his poultry direct to a local consumer, but generally to a local buyer or co-operative. Poultry may be killed and dressed in local dressing plants or trucked in crates or shipped in special poultry railroad cars to some central dressing plant. At the dressing plant it is sorted and thin birds are put into batteries and fed fattening rations to put on the desired finish. When slaughtered, the birds are graded as to quality, weight, and sex, packed in boxes or barrels and shipped in refrigeration to consumer markets. Here they are handled by brokers or commissionmen who sell them to distributors who place them in retail stores. Quality and finish are important factors in getting good prices.

Poultry dressing plants are operated by individual corporations and co-operatives and render a marketing service not only to producers but to consumers. Central co-operative marketing associations handle both eggs and poultry, and are owned and controlled by local co-operatives. These large plants have sufficient volume to make possible efficient operation and a volume that attracts buyers in sufficient numbers to be a factor in determining the price paid. Some find it profitable to process the dressed poultry, to be served easily as canned poultry.

Turkeys are becoming more important as a clan of poultry. They are consumed most heavily during the holiday seasons of Thanksgiving and Christmas, and production is, therefore, aimed at these two markets, but more and more turkeys are stored in refrigerators, making them available during the entire year. The development of a breed of smaller, earlier-maturing turkeys will make possible the marketing of fresh turkeys throughout the year and hence may increase the demand.

MARKETING COTTON

Most of the cotton crop is sold as soon as it is picked, especially if produced by small producers. Many small producers are share croppers dependent on store credit for the supplies for the production year. As soon as the cotton is picked it is ginned and sold to satisfy their store account. Larger producers tend to store the ginned cotton and hold it for a rise in price. The cotton is hauled from the field to the gin where the fiber is separated from the seed. The fiber is baled and stored in warehouse cotton mills. The seed is sold, the oil is extracted, and the seed residue, made into cake or meal, is sold as a concentrated protein feed to supplement livestock rations. The increased use of the oil has given the seed added value as a cotton by-product.

The ginned cotton may be sold to the operator of the gin, local merchants, local buyers, or buyers for large cotton companies, or handled through a co-operative marketing association. It is then rebaled into more compact bales and held for sale to cotton mills. Prior to 1930, about one half of our cotton was exported to foreign countries. With the decline of our foreign markets, less cotton was exported and prices declined. Government loans on cotton have since tended to fix a minimum price, thus supporting the cotton market. Cotton is sold on the basis of sample. Length of fiber or staple is an important factor in determining grades.

MARKETING TOBACCO

Tobacco is sold by individual producers to local buyers or through local co-operative marketing associations and auctions in producing areas. The price is determined by the supply and demand for the various grades in a wide variety of uses. There is no central market for the tobacco where trading would determine prices. A few large tobacco companies dominate the market. The prices of finished products are relatively stable. The price of a certain quality or brand of cigar, package of cigarets, smoking tobacco, chewing tobacco, and snuff are fairly constant. Hence buyers know what they can get for the finished product and need no marketing device to shift the burden of risk of price change.

Current supplies dependent on the year's crop are less important, since tobacco is stored to permit time for proper curing and hence several years' supply is always on hand. Producers seldom hold tobacco in their own storage but sell about as soon as the year's crop is cured. If the individual producer sells his own crop, he depends on his knowledge of the grade of his tobacco and the market price as well as on his ability to bargain with the buyer. Local marketing co-operatives attempt to represent the producer in bargaining with a buyer. Large district co-operatives have been organized to represent the local co-operatives and producers in selling to large tobacco companies.

The most common method of selling tobacco is by auction. These sales are held in large warehouses, when each lot is sold separately. Sales are made very rapidly and are made to the highest bidder. The volume of tobacco to be sold must be large enough to attract several buyers to insure competition, and some assurance must be given that the quality of each lot is recognized by the buyers. The auction tends to assure competitive bidding.

MARKETING WOOL

Wool is an important by-product of the sheep enterprise. It is sold individually by the producers to local wool buyers or through local co-operative wool pools. It is sometimes consigned to district or state-wide pools for sale to wool brokers, and to woolen mills. A national co-operative wool marketing association with headquarters in Boston is an important factor in wool marketing. It is composed of state and regional co-operatives.

Farmers sell wool in the fleece as it it sheared off the sheep and "unwashed," or "in the grease." It is sold to the woolen mills on a clean or scoured basis. The wool shrinks roughly fifty per cent in the scouring process. This shrinkage is due to the elimination of wool, fat, and dirt in the process of scouring. An abundance of wool fat or yolk is desirable, but the presence of dirt and irremovable material, such as chaff from straw and burrs, is objectionable. Wool is classed as to fineness of fiber, which determines its use. Price is determined by the supply and demand for the various grades and classes.

Because of a wide range in shrinkage, wool varies in value or price and hence should be sold on a graded basis. Farmers and large producers of wool are not familiar with grades and may not be able to secure their full value. Local co-operative wool pools have been organized to attract competing buyers, and some associations have insisted on selling the wool by grade, each pool member being paid according to the grade and quality of his wool. State co-operative pools composed of individual wool producers and local pools exist in all wool-growing areas. They, in turn, are federated into a national pool to sell the wool to mills, thus representing the individual producer's interest on a national basis. Complete account of sales made for the producer not only provides an itemized statement of the grades and prices on his wool crop, but also the detailed deduction made to cover the various steps involved in marketing.

MARKETING POTATOES

Farmers sell some potatoes direct to local consumers, to local stores, and to local buyers. They also sell through local co-operative marketing associations for shipment, if grown in sufficient quantity, by truck or railroad to terminal commissionmen or brokers who in turn sell to distributors for resale to jobbers and retailers. Potatoes are perishable and can not be stored from one season to the next. The entire crop must be marketed during the current year. The consumption per capita does not change materially with changes in price. People eat about as many potatoes when prices are high as when they are low. The current supply becomes a more important factor in determining prices. When the crop is large, prices tend to decline. A short crop with high prices encourages an increase in acreage which may result in a surplus as compared with demand and low prices. Yields per acre depend on weather, mainly moisture, and hence vary widely as seasons vary. As a result, potatoes are regarded as a rather speculative crop. They are subject to diseases, such as scab, rots, and wilt, that affect their quality. Being a vegetable, they are easily bruised in the usual methods of handling during digging and marketing and may suffer in their market value. Since they grow in the ground, they may carry more or less dirt that is objectionable to the housewife. They are not always well graded as to size and quality. Farmers must be paid a price that will make grading and brushing or washing pay. The ultimate consumer must be willing to pay for quality potatoes.

Potato Storage. The farmer may store his potatoes on the farm in a cool humid basement, warehouse, or cellar. He must be able to move them out of storage when the price suits him, even in winter. As a result, potatoes are usually stored in warehouses alongside railroads where they can be loaded into heated refrigerator cars in winter and so moved into distributing channels as consumer demand dictates.

Potatoes are commonly sold to buyers who sell direct to large distributors or to commissionmen who supply jobbers and wholesalers. Local co-operative potato-marketing associations have been organized to serve as local outlets. In some states these local co-operatives have federated into state co-operative marketing associations to serve as brokers or commissionmen. Some such state associations have failed because of lack of working capital needed for operation or because the cost of operation, due to lack of volume or inefficient operation and selling, was too high. Large deductions from the market price and lower net prices to the producers resulted. With the failure of the state co-operative, local co-operatives also ceased to operate. To be successful, agencies marketing potatoes must furnish the consumer an attractive package of potatoes of a quality and price in keeping with the price paid. Adequate state and Federal grading laws, together with fair marketing agreements among growers in areas producing similar potatoes, would be helpful in a marketing system for potatoes.

MARKETING FRUITS AND VEGETABLES

Home fruits and vegetables are usually sold fresh and are mostly consumed in their original form. Perhaps a larger proportion are sold for local consumption than of other farm products. In their own gardens and orchards farmers can usually produce a large proportion of fruits and vegetables for home use. Most of the fruits and vegetables are produced by commercial producers who have specialized in the production of these crops either for the local market or more distant population centers. Local producers sell direct from house to house, supply local stores or sell on a central produce market in larger centers. Since fruits and vegetables go more or less directly to the consumer in their original form, quality, uniformity, and package are pleasing to the consumer and maintain good will.

Near large centers, along main traveled roads, producers can sell fruits and vegetables as well as other farm products by using roadside stands. Here they receive the full price paid by the consumer and capture the marketing margin, since they perform all the necessary marketing functions. The same is true when, in municipal markets provided in larger urban centers, they sell direct to consumers. On municipal markets much of their produce is sold to retailers. Some of the produce offered there is sold to truckers who may bring produce out of season in that locality and buy in quantity for some distant market that offers an opportunity to resell. Truck buyers tend to equalize the supply of such products over a wider area, stabilize prices, and give the local producer the advantage of a wider market. They should be encouraged in this service and not hindered by barriers that obstruct such free movement.

Wholesale markets in large centers receive fruits and vegetables from all quarters of the world as well as fruits and vegetables produced locally. They serve important functions in making available for consumption a wider variety of products than would otherwise be possible, widening the market for all producers of fruits and vegetables. At the wholesale market, products are sold by brokers and commissionmen to wholesalers who in turn supply retailers. Fruits and vegetables are also sold there at auction to the highest bidder. This method assists in disposing of lots of products they may need to be regraded and repacked to salvage produce that comes in poor condition.

Fruits and vegetables are handled for producers by local co-operative produce associations that perform the functions of local buyers. These locals again may associate themselves in a co-operative wholesale that serves a larger area and performs the functions of brokers and commissionmen in supplying wholesalers. The large co-operative wholesalers handle a large volume and make it possible to carry on a national advertising program that increases the demand for the products handled by finding new consumers and additional outlets. They also process fruits and vegetables and create a new outlet for products that would not be disposed of fresh, and make longer storage possible.

Refrigeration in transport has made possible the movement of perishable fruits and vegetables for long distances. Refrigeration in storage has made possible the storage of fruits and vegetables and so extended the period in which they are available for consumption.

POSSIBLE IMPROVEMENTS IN MARKETING

Some general suggestion for improving the marketing of farm products might be made to insure greater efficiency of operation in order that the cost of marketing may be reduced and the net price received by the farmer increased.

Farmers might well consider more carefully the quality of products desired by the consumer. More attention might be given to the production of milk under more sanitary conditions. Consumer-size packages of farm products, such as dried milk, dried eggs, potatoes, and fruits might help to sell them to more consumers and widen the market for them. General use and acceptance of state and Federal grades would insure greater uniformity and facilitate a more accurate determination of price in relation to quality. The elimination of waste, duplication of service, narrowing the spread, or the marketing margin, between the producer and the consumer and thereby increasing the efficiency of necessary marketing functions, would narrow marketing margins. The consolidation of volume now handled by many small relatively inefficient marketing agencies would insure volume, making efficient operation possible. Elimination of unnecessary handling and hauling would result in less duplication of service. If marketing by individuals and corporations can not be done more efficiently and at lower cost, the need for improvement becomes a greater challenge for competition from co-operative marketing associations. Co-operatives must do the job of marketing as well or better and at less cost, if they are to succeed in the field of marketing.

Suggestive Questions

1. What is your definition of a market?
2. What factors determine market price?
3. Name some vital marketing problems.
4. What are the essential differences between an agricultural co-operative and a corporation?

Suggestive Activities

1. List all the agricultural co-operatives known to operate in your county.
2. Acquaint yourself with as many of these as you can, and study their form of organization.

CHAPTER VI

PLANNED PRODUCTION PROGRAMS

In colonial days inadequate agricultural production was one of the problems with which the new settlers had to contend. At that time the concern was not what to do with products that were not needed, but, rather, how enough products could be produced. In that early day production methods were very crude and most operations required a great deal of labor. Much of the land had to be cleared before crops could be grown, and each family could cultivate only a small acreage, because most operations were done by hand.

As the population moved westward into the prairie areas, rapid expansion in agricultural production followed. Clearing the land was not difficult; the soil was fertile; and the development of machinery made a rapid increase in production possible. Even with a rapid increase in population and great expansion in industrialization, there was no question what to do with the great quantities of wheat, pork, beef, and cotton that the American farmers were pouring into channels of trade. Foreign countries were willing and able to buy most of that which was not needed in this country. Early in the twentieth century, however, a combination of national and world forces seemed to move together, resulting in distress periods for agriculture, developing later into a general economic depression. It was then that attention was directed toward the need for a nationally organized and planned program for agriculture, aimed toward the development of stability in the industry. This effort culminated in Federal legislation that provided for a reduction of surpluses, support to market prices, shifts in production, and promoting the conservation of soil fertility.

PRODUCTION PROBLEMS OF THE FARMER

Some products of the soil are ready for consumption as soon as produced; others must be processed or converted into more usable or more desirable forms to satisfy human needs. Garden crops, for instance, are immediately edible or can easily be made ready for human use. Forage crops, on the other hand, are fed to livestock, producing meat or milk that is a readily usable end product. Cotton or flax fiber must undergo certain preparatory processes before it can be made into cloth.

Family Needs. Before the development of present-day technical methods of production each farm family found it necessary to depend on the farm for most of its needs. Various kinds of food were produced, some of which required special handling in order to preserve them for consumption when needed. Shelter was improvised in wooded areas by hewing logs into proper length and shape and putting them in place. In prairie areas the walls of houses and other buildings were built from the sod covering the surface of the land. It was largely a matter of applying labor and native ingenuity to the materials available.

As the mechanical skills became more common and transportation provided a greater opportunity for exchange of goods, particularly those which were manufactured, rural people ceased to depend entirely on the farm for all their needs. Instead, they could buy in finished form many, if not most, of the necessities. With progress in the commercial skills, an increasing number of necessities and luxuries became available to most residents of the land. Production programs for individual farmers had become somewhat more simplified, because they could then grow the products to which their farm was best adopted, sell them, and buy many articles that they previously had to grow and process or go without.

Feeds for Livestock. In planning a production program for most farms, consideration is usually given to the choice of crops which will best meet the feed requirements as to kind and amount. While a well-organized livestock program can be utilized to serve as a means of converting unmarketable roughages, it is of great importance that a cropping scheme be devised that will furnish the kinds of feeds which will develop and finish commodities for the market, rather than merely provide a subsistence ration for the animals.

Most farms depend on the breeding herds and flocks for the production of replacements and for the animals that are to be grown out and finished for sales.

To carry through a profitable livestock enterprise successfully, be it hogs, cattle, sheep, or poultry, proper emphasis must be placed on a feed supply that is: (1) suited to the requirements of the stock; (2) dependable from year to year; and (3) sufficient for the whole season's requirement, so as to avoid the necessity of "skimping" on feed or of reducing the number of livestock. Good management gives proper recognition to a substantial feed supply of the right kind. The stability of livestock enterprises is largely dependent upon it.

Products for Exchange. In the early portions of this chapter, considerable emphasis was given to the point that exchange played a significant part in the economy of a farm program. It was noted, also, that exchange became a more prevalent practice as the trades, skills, and opportunities for commercial intercourse developed in importance.

And, in its broader meaning, the term "exchange" embraces all transactions wherein products are sold for a cash consideration and the money received is used to purchase goods or services that are necessary to carry on farming operations, pay debts, and maintain an appropriate living standard.

A production program on the average farm should make provision for crops, livestock or livestock products to be ready for sale when the markets offer the best price. The limitations of seasonal conditions must be reckoned with to some extent, but the farmer who is able to put a finished product on the market before the heavy run of deliveries of that commodity begins usually realizes a better price.

It is generally recognized that cash income from a variety of sources offers promise of greater average annual return. Planning for diversity of income is a significant phase of good farm management.

Contributions to National Needs. The people of this nation have become increasingly dependent upon one another. Urban dwellers now are vitally affected in the event some force or emergency materially reduces total production of a certain commodity. They were not so vitally affected when each family more nearly depended upon its own labor and resources. An early frost in the fruit belt will ordinarily reduce the yield of certain fruits and make the general supply less plentiful. The grocer will then have to pay more for the supply of that fruit which is available, and the housewife will likely choose to use less for her family table, because the scarcity has enhanced the price or less costly fruits may be substituted.

Present speed of transportation and efficiency of refrigeration has greatly reduced the distance, for instance, between the California or Texas truck farm and the New York hotel dining room when measured in time necessary to span the area. These modern methods of transportation have made it possible for many to accept as commonplace what was at one time extremely difficult or practically impossible.

The farm production methods and the results that have been gained in terms of greater quantities of highly nutritious foods, made available at nearly every town or country store in the nation, mark an important area of achievement in distribution. The nation can boast of great distances, but its people are as neighbors in a small community. Farmers can now take advantage of every opportunity to supply that which is in demand. If the price is adequate to make it a worth-while transaction, distance has been largely overcome.

National needs are now more fully met by national production. To the individual farmer that means that he is now better able to contribute to demands that were formerly often incompletely satisfied. It also means that, as the production field has expanded, competition has become more keen between areas as well as between individuals.

PRODUCTION FOR COMMUNITY NEEDS

The pioneer who settled in a new area was concerned with the problem of providing for his own immediate family needs. That circumstance constituted a rule which he was forced to adopt in the interest of self-preservation. But, as soon as joined by others who were endeavoring to establish themselves, he was usually ready to share what he had to make it possible for all to survive.

Before the development of transportation methods, people on the land attempted to provide for the requirements of those whose material needs could not be met by their own efforts. It was not always possible to provide enough, but the climatic and biological forces which occasionally joined to reduce the size of the crop would, in other seasons, co-operate to provide an abundance. In years of good yields everyone had enough—in years of short crop it was often necessary to divide.

Perishable Products. The advances in refrigeration and rapid transportation have extended the opportunity for supplying perishable products such as fruit, vegetables, milk, meat, and eggs to many people who previously were denied the privilege and benefit of many of those products. When it was not possible to transport delicate fruits and vegetables great distances, obviously the market outlet was substantially restricted. Smaller acreages were needed to meet the most liberal requirements, and often quantities of certain crops went to waste when the local needs were fully satisfied. The element of perishability now plays a less important part than formerly.

With methods of distribution developed to serve more distant areas, competition in marketing now demands improvement in the quality of products. When local areas were dependent on the immediately surrounding territory for their agricultural goods, quality was recognized as desirable, but usually only the more progressive farmers endeavored to compete on that basis. Each community had a few farmers' wives, for instance, whose butter was considered most desirable. Often a small premium was paid for it at local stores, but the bulk of the farm-made butter was unsatisfactory in quality as measured by present-day standards. Each producer operated independently and was but little concerned about the quality of his own goods, much less about that of his neighbors.

Pooling of Products. It is of interest to note that, with the development of methods of rapidly moving perishable and semiperishable products, there came a significant change in the relationship between individual producers. Shipping facilities encouraged the assembly of carload quantities as a minimum to qualify for favorable transportation rates. Local dealers established services whereby they would purchase the products from farmers, assemble them into car lots, and market at a distant point. Livestock marketing was looked upon as a somewhat mysterious and often hazardous operation, and the "cattle buyer" operated on a basis which usually yielded him a substantial profit. Farmers eventually learned that they could as well market their own livestock by assembling a sufficient quantity. Thus co-operative livestock shipping associations were formed.

Dairy farmers who had skimmed the cream from settling pans and churned it into butter discovered that through group action they could improve their technique by getting together, pooling resources, and establishing a co-operative "butter factory," or creamery. Thus, gradually the farmers were given encouragement to expand their production programs. There seemed to be no limit to market outlets and increased quantities were about the only objectives with which the aggressive farmer had to concern himself.

The Limit Is Reached. In preceding pages the discussion contains no reference to such terms as "controlled production," "surplus," or "quotas." As the operations on farms were largely directed toward methods by which greater quantities of wheat, corn, hogs, cattle, butter, eggs, and other products could be produced, there seemed to be little need to be concerned about what to do if more was produced than could be consumed or sold. While the prices which farmers received fluctuated considerably, it was possible to find a market at some price for all products.

TABLE IX—CORN: ACREAGE, YIELD, PRODUCTION, SUPPLY, AND DISAPPEARANCE SINCE 1926[1]

Year beginning October	Harvested acres	Production	Yield per acre	Carry-over Oct. 1	Total Supply Oct. 1	Net exports	Disappearance
	1,000 acres	1,000 bu.		1,000 bu.	1,000 bu.	1,000 bu.	1,000 bu.
1926	99,452	2,546,972	25.6	278,005	2,824,977	14,341	2,593,354
1927	98,357	2,616,120	26.6	217,282	2,833,402	17,619	2,723,583
1928	100,336	2,665,516	26.6	92,200	2,757,716	41,399	2,567,977
1929	97,805	2,521,032	25.8	148,340	2,669,372	8,119	2,524,921
1930	101,465	2,080,421	20.5	136,332	2,216,753	1,733	2,047,249
1931	106,912	2,575,611	24.1	167,771	2,743,382	4,058	2,468,991
1932	110,577	2,931,281	26.5	270,333	3,201,614	8,713	2,806,580
1933	105,963	2,399,632	22.6	386,321	2,785,953	3,928	2,444,935
1934	92,354	1,461,123	15.8	337,090	1,798,213	*35,812	1,768,949
1935	95,804	2,303,747	24.0	65,076	2,368,823	*20,228	2,209,504
1936	93,020	1,507,089	16.2	179,547	1,686,636	*103,237	1,723,651
1937	93,741	2,651,284	28.3	66,222	2,717,506	138,383	2,216,339
1938	91,792	2,542,238	27.7	363,093	2,905,331	33,927	2,310,522

*Net imports.

The phases of production that have been discussed were characterized by one important feature. Farmers, individually and collectively, were not able to stabilize quantity of production to correspond to needs. They produced as much as they could, marketed when they thought best, and generally continued to place what they assumed was personal interest above that of all the people engaged in the industry. The piling up of great surpluses was unavoidable in the nonperishable or semi-perishable types of products. The problems which the situation provoked were serious because the lack of an effective demand, locally and for export purposes, resulted in very low prices on products in storage as well as for the new crop of each season.

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[1] U. S. D. A. Crop Reporting Board.

The Table on page 143 illustrates the situation relative to corn during a 13-year period. Note the large variations in yield, total production, carry-over, and net exports. The variation in yield can be largely ascribed to climatic conditions, although the rapidly-increasing use of hybrid varieties probably had some influence in yield per acre in the later years.

PRODUCTION CONTROL PROGRAMS

The plight of agriculture during the years that followed the economic collapse of 1929 was sufficiently serious to focus national attention on the general problem; and the Federal Government, under enacted legislation, proceeded to establish machinery designed to correct the conditions which brought on the paralysis of the agricultural industry.

The Agricultural Adjustment Administration. The Agricultural Adjustment Administration was established by Federal law in 1933. Its provisions prescribed an organization pattern headed in the Department of Agriculture, with the Secretary of Agriculture delegating operating functions to an administrative organization located in Washington, D. C. State and local interests were supervised by committees composed of chosen representatives of farmer co-operators.

The original A.A.A. (Agricultural Adjustment Act) provided principally for:

1. Adjustments in production of wheat, corn, cotton, hogs, rice, tobacco, and dairy products.
2. Benefit payments, derived from processing taxes and paid on a voluntary reduction contract between the government and each co-operating producer.
3. Expansion of markets, encouragement of exports, and regulation of marketing methods.

The Agricultural Adjustment Act of 1933 also required an extensive field organization to put its provisions into effect. It made necessary the promulgation of a comprehensive program of education in order that the regulations might be uniformly interpreted in all the counties and communities in the nation. This educational program was undertaken by the State Agricultural Extension Service in co-operation with the A.A.A. and the Federal Agricultural Extension Service of the United States Department of Agriculture.

Farm producers were called upon to set up the administrative machinery in each agricultural county serving as local headquarters, with townships and communities having locally elected committees to direct local phases of the program.

The validity of the Act of 1933 was challenged and the United States Supreme Court handed down in 1936 a decision which sustained the contention that the Act was unconstitutional.* All activities of the A.A.A. were, therefore, immediately suspended.

Soil Conservation and Domestic Allotment Act of 1936 and 1938. In the administration of the original agricultural adjustment program, an increased interest was evidenced in the conservation of soil as a part of the national program. When it became necessary to develop a new program to take the place of the Act of 1933, agricultural leaders recommended that soil conservation be a basic principle in the new law proposed for enactment.

The general plan provided that certain crops be designated as "soil-depleting" and others as "soil-conserving." Such crops as wheat, corn, cotton, and other grain crops were included in the first category, and legumes and grasses were placed in the "soil-conserving" class. Payments were earned by co-operators by shifting to certain planned cropping programs which required usually that the acreage of soil-conserving crops be increased with a corresponding reduction in the acreage of soil-depleting crops. Additional payments might be earned by carrying out certain approved "soil-building practices."

The Agricultural Adjustment Act of 1938 was enacted to fit into previously-adopted legislation and to provide greater opportunity to meet the need for shifting production emphasis from certain specified crops to others and still retain the soil conservation features. The extent to which shifts might be made was governed largely by the national need for the respective crops and the ability of farmers to make the shifts.

The allocation of acreages of designated crops to each particular farm was determined by first adjusting the increase or decrease assigned to the state, to a county basis, and thence to each farm, using the production history of the state, county, and farm as the basic guide.

The Agricultural Adjustment Act of 1938 was a particularly important piece of legislation, as it heralded the inauguration of several new farm programs. They were:

1. Price and parity payment program to growers of certain crops.
2. Commodity loans to co-operators.

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* Decision of Supreme Court in the Hoosac Mills Case, 1936.

3. Marketing control of surplus crops when approved by two thirds of the producers voting.
4. Freight rate investigation and study.
5. Federal crop insurance on wheat and cotton.
6. Purchase of surpluses for distribution to persons on relief.
7. Export subsidization of farm surpluses.
8. Establishment of research work to seek new uses for surplus crops.

Proper Land Use. Nationwide interest and concern have been greatly stimulated regarding soil conservation. Numerous instances have been revealed wherein the top soil has been lost by washing or blowing, and, generally, can not be replaced. Observation and study have also directed attention to the fact that there is much waste of soil resources as a result of improper cultural practices. Certain areas have topography or soil texture and structure which does not permit proper handling for crop growing. In other instances limited rainfall makes the growing of certain crops a hazardous enterprise, fraught with a high probability of failure to the operator. The Soil Conservation Service now organized in the United States Department of Agriculture has developed far-reaching programs for preventing loss of soil by erosion.

Organized efforts have been directed toward reducing the extent of improper land use. Individual farmers in some cases have adopted methods shaped after Federally sponsored demonstrations that were more appropriate to the soil, topography, and climate than the methods being followed. Encouragement is given also to techniques that minimize the possibility of loss through improper land use.

Co-ordination of Land Use with Production Programs. In the administration of the agricultural conservation program, particularly in allocation of quotas for certain types of crops, consideration is given to the adaptability of the area for the growing of the specific crop. On a regional or state basis, adjustments are made in the regulations to permit equitable opportunity for participation in the program through the growing of such crops and carrying on of such practices as will be conducive to maintenance of soil structure. Proper land utilization embraces the field of activity which influences all phases of soil management, and the selection of appropriate crops occupies an important place. In some farming areas where wind or water erosion constitutes a serious problem, the carrying out of control practices is recognized by granting "soil-building" payments to co-operative farmers.

To some extent the establishment of production quotas is influenced by the adaptability of the area for the growing of the crop without unduly jeopardizing the future use of the land. There is, of course, a practical limitation to the extent to which production quotas can be changed. Obviously, no area can be expected to make extensive and abrupt shifts in types of crops except as the alternative crops have somewhat similar requirements with respect to machinery and equipment, and can otherwise be fitted into the general crop program without impairing the farm income.

NATIONAL PRODUCTION PROGRAM

The development of the national goal for any product requires the determination of certain information. The following formula will explain, in an elementary way, how the goal is established:

National Needs—Present Stocks—Goal. Under "national needs" must be included domestic requirements, export requirements, and adequate carry-over into succeeding years. "Present stocks" represents the quantity of the product which is available and which can be reckoned to reduce total requirements. The "goal" is the amount of the product which will provide for all needs and for a satisfactory carry-over in the event the goal should be reached. The national goal is broken down into state production goals, and assigned to the various states. The result may mean a reduction in effort on the part of producers or it may necessitate an increase. State quotas are determined largely on the basis of past production records, covering several years, adjusted in some instances to compensate for situations which might cause inequity to certain states or to give desirable trends encouragement.

State Production Programs. The production goals that have been assigned to states must, under the direction of a State A.A.A. Committee, be reallocated to smaller county and township units in the organization pattern. The task of administering the program in all its ramifications makes this process necessary. County quotas, or goals, are fixed after reviewing the production data for each particular crop grown in the county during a certain period. County goals, in terms of acres to be grown, anticipate a gross production and a quantity that will be available for meeting the over-all national needs after providing for local feed, food, seed, or other requirements.

County Production Programs. At the county level the quotas or goals are assigned direct to the farms by a County A.A.A. Committee. Local committees, composed principally of farmers, develop the plan for meeting the production they are called on to furnish or they lay out the restrictive requirement necessary to meet the assigned quota. The production history is again used as a guide. Crop acreages grown in past years are grouped to establish a "soil-depleting base." Yield possibilities are estimated and assigned to each farm serving as basic data in setting up a program for compliance.

In arriving at appropriate goals for each farm, the soil-conserving possibilities are given consideration, particularly where there is obvious need for special handling to prevent rapid deterioration of fertility.

Thus each participating farmer, representing an individual among many thousands of farm operators, assumes his responsibility for a part in a national undertaking, working through local, county, and state organizations to achieve collectively what is determined to be the national objective. The program contemplates an adequate supply for local needs first and for the nation and world needs when home requirements are met.

SAFEGUARDS FOR FUTURE PRODUCTION

The job of providing the nation with an ample supply of food, fuel, feed, and fiber does not end with the close of a season. As long as people have physical wants that must be satisfied, the soil must be relied upon to grow plants which can ultimately be converted into their most satisfactory form.

Reliance on the soil requires consideration of soil fertility. Soil with little or no fertility has little value, even if other requisite qualities are present. Fertility of the soil, when destroyed or removed, must be replaced. To retard the rate of depletion, then, is a practical form of fertility conservation.

In recent years considerable emphasis has been placed on the advisability of retaining the fertility inherent in soil and to increasing the plant-food content for future use. Excessive cropping and other exploitive practices have been discouraged, and constructive land management plans have been urged that place the long-time interests above the immediate expediencies.

Ever-Normal Granary. Storage of nonperishable farm products for future needs, eliminating the dumping of those products on glutted markets, is one of the important efforts of the Federal Government to stabilize prices for farm commodities. In years when conditions have been favorable, the total crop has been greater than the normal channels of trade could absorb. Surpluses have been held on farms under commodity loan programs, and, when it has been necessary to make way for succeeding crops, storage facilities have been provided which have resulted in the building up of great stocks of wheat, cotton, corn, and certain other commodities to be held in reserve against possible reductions in new crops or to meet unforeseen foreign demands. This program of orderly storage has had a stabilizing influence on prices of such crops; it has added a sense of security to the nation through the knowledge that a calamity through crop failure is practically out of the question; and it serves as an effective method in reducing the rate of fertility depletion. The stocks of produce that have been stored for future needs represent a recognition that soil resources are to be preserved as well as to be used.

THE ECONOMIC PLAN OF THE FUTURE

The intelligent use of land is of major national concern. Agriculture, in all its various forms, will continue for a long time to be a source of livelihood for millions of families, and, because of that fact alone, its importance will likely encourage much support for national programs. Rural people must appreciate the fact that they deal with resources which are not for the present generation alone but for future generations as well. Satisfactory standards of living are not possible on farms when the soil has ceased to be productive. People may attempt to sustain themselves on land which erosion, for instance, has destroyed, but eventually abandonment results. Restoration is a long-time process as was the job which nature performed when the soil was first formed. Preservation of what remains and building for greater use are a satisfying objective, when all the elements of the undertaking are understood. To understand the factors which govern in the proper use and maintenance of the many types of soil which comprise the agricultural area is the task ahead for those who wish to serve agriculture. An exploitive plan is not conducive to satisfaction of the natural desire of most farm people—to grow living things abundantly.

THE U. S. D. A. AN AID TO FARMERS

The growing, processing, and marketing of the crops, livestock, or livestock products in various regions having peculiar soil and climatic conditions have required specialized research work, which often could not be sustained by the relatively small number of persons thus engaged. Services that have a national application would not be provided if they depended on individual areas to furnish them. The United States Department of Agriculture is organized on a national basis with abundant facilities to provide appropriate services for the families engaged in farming. Divergent interests are not removed, but efforts are directed and inspired from a national viewpoint rather than from that of individuals or groups. The administrative head, having a seat in the President's cabinet, represents agriculture on an equal basis with other economic groups, is able to assist in planning national over-all programs, and to speak for all farmers, regardless of their localized interests and objectives.

The department is organized on a comprehensive basis, taking into full account every possible angle that affects agriculture. It is concerned with research in a multitude of fields of activity, ranging from family health and nutrition to the growing of forest products. Results of experimentation that are worthy of release are disseminated to farm families through publications and extension services. Market reports are assembled at all principal market points and made available to farm families by radio, newspaper, and letter.

Certain controls are maintained under department jurisdiction. Typical of that type of service is the plant quarantine, Federal grading services, stockyards regulation, and many others. Educational services are given partial support by the department, which include agricultural extension, vocational agricultural courses in high schools, radio programs, and publications issued by the various agencies.

The department administers a number of "action agencies" whose functions are to carry out operational programs. The A.A.A., F.C.A., F.S.A., S.C.S., C.C.C. programs are only a few of the many that serve agriculture in one manner or another. It is significant that every activity of the Department of Agriculture, when traced back to its fundamental purposes, will end in the farmer's yard. The many functions and activities are intended to serve agriculture; and the individual farmer, in many instances, can not encompass by imagination the diversity of the activities that are supported year after year to make his farm, his family, and himself contribute in the greatest degree to the national well-being.

Suggestive Questions

1. What were some of the difficult problems of the pioneer farmers in your community? (Learn by consulting available histories and by inquiry from early settlers.)
2. How did they overcome them?
3. What were the objectives in each individual farmer's program in pioneer days?
4. What forces brought about changes in the programs of farmers in later years?
5. What, if any, are the Federal Service Agencies operating in your community?
6. What is the function of the "Ever-Normal Granary" in the National Agricultural program?

Suggestive Activities

1. Make a list of the farmers who have been longest farming in your community.
2. By visits to their farms and inquiry, learn what changes they have made in their methods of operation since starting to farm.
3. With the help of your instructor and other members of your class, plan a **"visit for observation and information"** to the local offices of any federal agencies operating in your community.
4. Write a report on the **functions and methods of operation** of one or more of these agencies.

CHAPTER VII

PRINCIPLES OF GENETICS

Farmers of today or farmers to be should be interested in the fundamental principles underlying the improvement of plants and animals. Just as in the realm of physics and chemistry, great progress is being made in the development of new types of machines, improved chemicals, and in the applications of science to better living. So are the breeders of plants and animals making great progress in the production of varieties and types that will be more suitable to the demands of advancing agriculture. The farmer must meet increased competition, and one of his best methods of meeting it is to take advantage of all the possibilities of scientific agriculture.

It is assumed that the successful farmer of the future will be the one who manages his farm on a scientific basis. He will be informed as to the best agricultural practices and know why they are best. He will not consider the growing of unsuited disease-susceptible varieties of crops; but, instead, through his contact with his agricultural experiment station and the other agencies disseminating agricultural knowledge he will acquaint himself with new and improved varieties and be ready to utilize them as soon as they are available. In the same manner he must be informed as to the best breeds of livestock for his purposes and the recognized methods of management.

The farmer who avails himself of the latest advancements based on the scientific principles involved, although he need not become an expert, is much better able to utilize the fruits of research to obtain the greatest returns.

REPRODUCTION PERPETUATES SPECIES

Every student has observed how a seed plant, such as wheat, grows, blooms, produces seed, matures, and dies. In general, it is believed that the primary objective of most plants and animals is to reproduce and thus perpetuate their kind. Without this reproduction the various species would soon disappear. The short-lived crops, such as wheat, oats, and barley, would cease to exist at the end of one year. The longer-lived perennials, such as alfalfa, timothy, and bluegrass, would live longer, but eventually they would tend to disappear. Nature has guarded against such a calamity by providing means whereby the various species may reproduce and thus insure continuation.

The process by which a plant or animal produces offspring is known as reproduction. As we shall learn later, the new individuals may be identical with the parent or they may vary rather widely. Most plants are composed of two classes of structures: the vegetative and the reproductive. The vegetative portion consists of the root, stem, and leaf, while the reproductive organs of a common plant include the flower, fruit, and seed.

In plants one encounters two types of reproduction. These are referred to as sexual and asexual. In sexual reproduction there is a union between sex cells (gametes) of two types, male and female (sperm and egg). This type of reproduction is common and may be illustrated with corn, where the male cells are produced in the tassel and the female cells are borne on the ear. Asexual reproduction is sometimes referred to as the vegetative type. Here no sex cells are necessary for the production of new offspring. Common examples are the methods of reproducing fruit trees and the use of tubers in growing potatoes. In the fruit tree, such as the apple, a portion of the stem (scion) of the variety to be reproduced is grafted on a stem (stock) whose root may be a wild crab or other type incapable of producing good fruit, but hardy. Every farm boy is familiar with the planting of potato tubers to produce new tubers. The student should recognize that in both examples flowers and seeds may be produced, and that, if the breeder wishes to improve the varieties, he must make use of sexual reproduction.

Reproduction in animals is very much the same as sexual reproduction in plants. The male sex cell (sperm cell) is transmitted from the male to the female, whereupon, under favorable conditions, it unites with the female sex cell (the egg) and thus accomplishes what is termed fertilization. The fertilized egg develops into a new individual possessing characteristics of each parent according to well-defined principles of heredity.

The term heredity refers to the tendency for the expression of the characters of the two parents in the newly-formed offspring. In some cases the offspring may resemble one parent; in other cases, both parents or neither parent, depending upon the breeding capabilities of each. Some of the implications involved will be considered later. Investigations of the laws of inheritance led to the modern science of genetics.

GENETICS A NEW SCIENCE

The science of genetics is comparatively new, the term having been coined by Bateson in 1906. The word genetics is derived from a Greek verb that means "to be born." The science has developed rapidly as investigators have learned new principles and their significance in the improvement of plants and animals. The modern geneticist seeks to explain the results of crossing plants and animals. Surprising results are obtained and explanations are sought. Through an understanding of the causes and results the geneticist is able to predict the possibilities from certain types of crosses which may be the basis for a plan of improvement. This improvement by controlled mating is commonly referred to as breeding. Today, then, we have the science of plant and animal breeding based upon the fundamentals of genetics and other sciences.

MENDELISM

Gregor Mendel, an Austrian monk, working in his garden, discovered important principles now in everyday use by breeders of both plants and animals. In 1865, Mendel published the results of his discoveries, but it was not until 1900 that they received recognition. Since the rediscovery of Mendel's principles, the science of genetics has developed by leaps and bounds.

Mendel experimented with several types of plants, but his work with the common garden pea led to his far-reaching discoveries. He was anxious to learn how the characters of the offspring of a cross between two plants were inherited. He crossed varieties of peas in which one parent differed from the other. Here we shall consider but one character, although he published the results on seven pairs of characters.

Mendel crossed a tall variety of peas with a dwarf type, by transferring the pollen (carrying the male sex cells) from one plant to the stigma of the other plant. Thus the plant from which the pollen was taken served as the male, while the plant upon whose stigma the pollen was placed served as the female. When he planted the seed resulting from the cross, or hybrid, all the plants produced in the first hybrid generation (F_1) were tall. As the pea is self-pollinated, he permitted the plants to develop normally. The seed from the plants was harvested and in the second hybrid (F_2) generation approximately one fourth of the plants were dwarfs and three fourths were tall, giving a proportion of 3 tall plants to 1 dwarf. Again he harvested seed and found that all the F_2 dwarf plants produced only dwarf plants while approximately 1 out of every 3 of the tall plants bred true for the tall character. The remaining two thirds of the plants produced offspring of which the ratio was similar to that of the original hybrid, 3 tall to 1 dwarf.

Sex cells of parents: T (tall parent) and D (dwarf parent)
F_1 (first hybrid generation): TD - tall because the tall character is dominant
F_2 (second hybrid generation): 1 TT 2 TD 1 DD
(All tall) (All dwarf)

The F_2 may be expressed by a checkerboard plan as follows:

Male Gametes

		T	D
Female Gametes	T	TT	TD
	D	TD	DD

All the plants having the combination of TT will breed true for the tall character; all plants having the combination of TD will be tall; but, in the next generation, will segregate in the ratio of 1TT : 2TD : 1DD. All plants having the combination of DD will be dwarf plants and will breed true for this character.

Mendel noted that while the plants in the hybrid F_1 carried the genes for the dwarf character, all were tall, because the tall character dominated the dwarf character. The tall character was called *dominant*, and the character which was hidden, *recessive*. The plant breeder uses the term *genotype* to refer to the genetic make-up of an individual. In other words, if one knows the genotype, one can predict the breeding results in making crosses with other individuals. The word *phenotype* refers to the appearance of the individual and may or may not indicate its breeding behavior. In the cross of the peas the genotype for all plants in the F_1 was Tall. Genetically some plants carried the dwarf genotype, or factors, for dwarf plants. In certain simple crosses between white and red-flowered plants, the seed produced the first year, when planted, yields plants which have only red flowers. Yet, when the seed is planted the second year, some of the plants develop white flowers. Thus the phenotype the second year for flower color was red, while the genotype individual carried genes for both red and white flowers.

The plant and animal breeders follow a practice of assigning simple letters to indicate breeding behavior. For example, a large A to denote the dominant character, a small a to denote the recessive character and a combination of the two letters to represent a combination of the two as Aa. Here we should introduce two new terms, *homozygous* and *heterozygous*. The term homozygous means alike, breeding true, forming one type of sex cell; heterozygous means different. When a plant or animal is heterozygous it produces sex cells carrying contrasting characters, as Tall and Dwarf or Brown eyes and Blue eyes. If we wish to represent a homozygous character, we write AA for the dominant character and aa for the recessive character. As would be expected, the heterozygous condition would be written Aa. To make this point clear, suppose we refer to the diagram of the hybrid peas. Since Tall is dominant, we will represent the pure, or homozygous, tall plant by AA. Dwarf, the short homozygous, recessive will be designated as aa.

Sex cells: AA (tall dominant) and aa (dwarf recessive)
F_1 = AA aa (heterozygous tall plants)
Sex cells from F_1: A and a
F_2 = 1 AA (all tall) 2 Aa 1 aa (all dwarf)

The AA plants will all produce tall plants, as they are homozygous.

The Aa plants are tall but are heterozygous. Accordingly, the plants will produce approximately 1AA : 2Aa : 1aa, as was the case with the progeny of the F_1 hybrids in F_2.

The aa plants are dwarf and will breed true for the recessive character, as they are homozygous. Since the dwarf character is recessive, it will breed true whenever it appears, as it can not be expressed when it is in the hybrid condition because of the dominance of Tall. Not all cases are simple, as many crosses are complex and ratios are not easy to determine. Genetic factors frequently operate to modify the normally expected ratios.

Applications of the principles of Mendelism will be apparent to the student when a more detailed consideration is given to the improvement of plants and animals as a result of breeding.

THE CELL IN HEREDITY

Before the student can understand the complicated problems of inheritance he must first become familiar with certain fundamental principles of cell division.

The Plant Cell. The cell is the unit of plant and animal structure. It was named a cell because Robert Hooke, one of the first men to examine the structure of living organisms with a microscope, noted that the tissue was porous somewhat like the cells of a honeycomb. Accordingly he proposed the name cell for the small box-like openings, and it has continued in use.

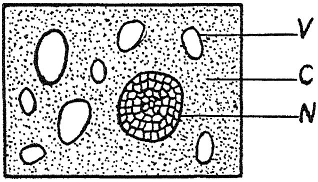

Figure 22. A plant cell; V, vacuole; C, cytoplasm; N, nucleus, location of the chromosomes.

Other investigators soon discovered that the cell was not an empty open pore-like structure, as was believed by Hooke, but living material filled with fluid-like substance. It is known now that the activities within the cell, chemical and physical changes, are essential to the growth development and reproduction of the individual and its perpetuation.

The cell is extremely small, in most cases being visible only when highly magnified. For example, the average leaf of a corn plant contains millions of cells, each performing its function in the life of the plant.

Although living cells differ greatly according to their functions, a few characteristics are common to all. Within the cell wall is a more or less spherical body known as the nucleus. The entire cell is filled with a fluid, a jelly-like granular-appearing substance known as protoplasm. That part of the protoplasm surrounding the nucleus is known as cytoplasm.

In a functioning cell are small cavities filled with water in which various substances are dissolved. These cavities are designated as vacuoles. In the green cells of plants we find small bodies (chloroplasts) capable of manufacturing plant food.

At present we are concerned with the nucleus which is the control center of the cell's activities. It is responsible for the formation of food by the chlorophyll-bearing plastids, the digestion and assimilation of foods, cell growth, and the transmission of hereditary characters in reproduction.

Ordinary Cell Division. When plant or animal tissue grows, it increases as a result of the formation of new cells. New cells are formed by the splitting of one cell (cell-division) to form two cells. Each of these cells divides again to form two more cells, and so this process continues as long as the plant or animal continues to grow. Not all cells continue unlimited division throughout the life of the plant. Certain cells assume specific functions such as the formation of a leaf, or seed. Cells in the growing parts, both in the root and stem tissue, divide rapidly as long as growth continues.

At the time the cell divides, the nucleus divides, so that each new cell has a nucleus. Within the nucleus are structures whose behavior is of fundamental importance in the breeding of plants and animals, since they carry the hereditary characteristics. These are the threadlike structures known as *chromosomes.* The word may be analyzed as follows: *chromo* refers to color; *somes,* to body. Early investigators were able to make these structures visible by staining them with certain dyes, so they were named chromosomes (colored bodies). Although no one has ever seen a genetic factor, it is known that the character-determining factors are carried in the chromosomes. The units of inheritance, determining the characters, are known as genes. Characters are expressed according to the genes which are present in the chromosome. For example, there is a gene for red color of the flower and a gene for the color of the fruit; in fact there are genes for each and every character that may be shown by an individual. The interactions between the genes contributed by each of the parents may result in complex inheritance problems which are beyond the province of this text. The more simple conditions will be considered as they illustrate principles of improvement.

Every species of plants and animals has a definite number of chromosome bodies in each of its cells. For example, every cell of the corn plant has within its nucleus 20 chromosomes.

When the cell and the nucleus divide, each rodlike chromosome is split lengthwise and one half goes to each of the two new cells formed. Thus each of the new cells formed by division of the one cell again has 20 chromosomes. The figure opposite will make this more clear. For purposes of illustration the division involves but 4 chromosomes which split so that 4 go to each new cell.

Early in the process of cell division the chromosomes align themselves as indicated in C. Two poles, or centers of attraction, arise on each side of the cell. Threadlike fibers, called spindle fibers, extend between the poles. By this time the chromosomes are split lengthwise and are arranged midway between the two poles. According to one explanation, each half-chromosome is connected with a spindle fiber. The spindle fibers contract, so that one half of each chromosome goes to one pole and one half to the other. Following this separation of the chromosomes into two groups, a new cell wall is formed, dividing the cell in half, and thus two new cells are formed. Each of the new cells has one half of each of the new chromosomes, or a total of 4, the same number that was present in the original cell.

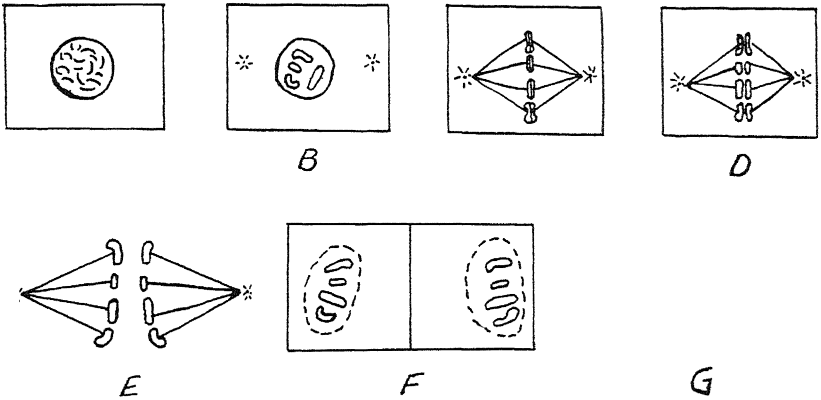

Figure 23. Cell division by mitosis. A, resting cell, with threadlike chromatin of the nucleus; B, the chromatin threads assume definite number and shape (four); C, the chromosomes align themselves in a plane across the cell with the spindle fibers between the poles and the chromosomes; D, each chromosome splits longitudinally, forming two parts identical in character; E, the two move apart toward the poles indicated by the stars; F, the chromosomes assume the form as in the original B; G, the chromosomes form chromatin threads in the resting stage and division is complete to form two new cells exactly like the original cell in A. The number of chromosomes, four, was chosen for simplicity.

From this stage the cells enlarge until fully developed. The new cells may continue the process of division as before. This process of ordinary cell-division is known as mitosis and is the one by which cell numbers are increased and by which the plant or animal grows.

REDUCTION DIVISION

We have seen how the cell divides in its ordinary processes of development to form new cells essentially like the original. These divisions result in the growth of the plant or animal.

Reduction division is fundamental to an understanding of genetic principles. As each parent contributes one half of the gametes, the new individual receives characters from each. Great improvement is thus possible through controlled matings. For example, the male parent may possess desirable characteristics not possessed by the female. On the other hand, the female parent may possess superior characteristics not found in the male. The mating of the two individuals may result in an off-

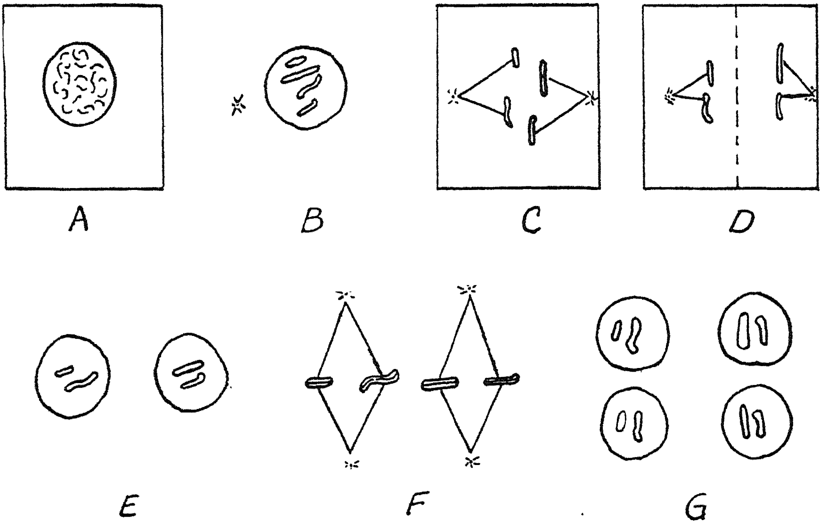

Figure 24. A schematic drawing of reduction division. A, a resting pollen mother cell; B, the first steps in division, the chromosomes differ in size and shape, there being two of each kind; C, the two of each kind pair up side-by-side and spindle fibers from the poles connect with the chromosomes; D, one chromosome of each kind goes to each pole, one half the original number of chromosomes being at each pole; E, the chromosomes next prepare for a second division and assume definite form as in B, except that there are but two chromosomes in each cell; F, each of the chromosomes splits lengthwise and aligns across the plane of the cell, spindle fibers attach and ordinary division takes place to form; G, the four daughter cells each with a reduced number (½) of chromosomes. When one of these cells, having a reduced number of chromosomes, mates with an egg cell also having a reduced number, the resulting individual, following fertilization, will have the full or complete number of chromosomes, in this case four. The example given is pollen or male cell; the same is true of the egg or female cell.

spring which inherits the good qualities of both parents. When such is the case, an improvement has been made through breeding. The student must bear in mind that the new individual may be less desirable than either parent, if each contributes certain undesirable characters to be inherited by the offspring.

As mentioned previously, both plants and animals of the higher forms reproduce sexually, that is, male and female gametes (marrying cells) are produced. The fertilized egg resulting from the union of a male gamete (sperm) with a female gamete (egg) is called a zygote (yoked cell). This zygote which develops into the new individual must have received its hereditary characters from its parent through the gametes. If the two gametes are of equal importance, it must have received half of its hereditary potentialities from the mother and half from the father. Since the new individual has the same number of chromosomes, it is evident that the number of chromosomes in each sex cell must be reduced to one half of the original number. If they are not, the fertilized egg would contain double the characteristic number of chromosomes. In the next generation the original number would be quadrupled and so on in geometric progression throughout the succeeding generations. Nature has guarded against this contingency by providing for a reduction division in the formation of the gametes.

As indicated in reduction division, the number of chromosomes is reduced to one half but in such a manner that the sex cells receive only one of each pair of chromosomes bearing contrasting factors. This division may be illustrated diagrammatically much as for ordinary cell-division. As stated before, there are two chromosomes of each kind and these two now pair. All the chromosomes pair together. The spindle fibers are attached to the chromosomes, but, in this case, instead of splitting, as in ordinary division, one member of each pair of chromosomes goes to each pole. Since a corn plant has 20 chromosomes, it forms 10 pairs and each of the newly-formed sex cells will be reduced to a total of 10 chromosomes, one of each pair, that is, one of each kind. Since the same type of reduction occurs in both the male and female cells, their union at the time of fertilization results in a return to 20, the normal number for the species.

The chromosomes are important because they carry the hereditary potentialities from each parent to offspring. These potentialities are called hereditary factors or genes and are responsible for the characters (characteristics) which we see in the developing individual.

The chromosomes may be thought to resemble strings of genes analogous to strings of beads. Each different kind of chromosome has a different string of genes. But, as we have seen, there are two chromosomes of each kind and at reduction division these two pair. The gene strings in the two chromosomes that pair are similar but may not be exactly alike, since one string came from the male parent and the other string from the female parent. They may carry genes for contrasting characters, as in the case when a blue-eyed individual mates with a pure brown-eyed one. The gamete of the one parent (containing the chromosomes and hence the genes) are all carrying the gene for blue eyes and unite with the gamete (from the other parent) carrying the gene for brown eyes. In the zygote are the two potentialities for eye color, one for brown and one for blue eyes; but the mature individual is brown-eyed because the effect of the blue is covered by the brown. The gene for brown eyes is said to be dominant over the gene for blue eyes and such an individual is said to be heterozygous (impure) for brown and blue as compared to the two parents which were homozygous (pure) one for blue eyes and one for brown eyes.

When, in this heterozygous brown-eyed individual, the reduction cell-division occurs, chromosomes carrying the genes for this eye color (brown on one chromosome, blue on the other) come together (pair) and separate, each going to one of the two daughter cells. Thus half of the gametes carry the gene for brown, and the other half carry the gene for blue.

What will be the offspring of a mating of two such individuals heterozygous for eye color? Since each produces two kinds of gametes, one carrying blue and the other brown, the sperm cell from the male carrying the blue gene may unite with a brown or with a blue-carrying egg, the new zygotes being (blue + brown) a heterozygous condition and (blue + blue) a homozygous condition pure for blue. Also a sperm cell from the male carrying the brown gene may unite with a brown or with a blue-carrying egg. The new zygotes would be (brown + blue) heterozygous and (brown + brown) pure for brown.

Since the two kinds of sperms and of eggs are formed in equal numbers, the four combinations occur in equal numbers, giving a ratio of ¼ pure brown: ½ heterozygous brown and blue: ¼ pure blue. Since brown is dominant, the eyes of the heterozygous brown-eyed individuals appear as brown as the pure brown individuals. Thus the ratio becomes ¾ brown eyes: ¼ blue. On the average, when two individuals heterozygous for brown and blue marry, 3 out of 4 of their offspring will have brown eyes and one out of every four will have blue eyes.

In order to understand how breeders are able to combine desirable characters from different varieties, let us now consider the case where the two individuals or varieties to be crossed differ in two pairs of characters. Suppose you cross a yellow dent corn with a white sweet corn. One pair of characters is the seed color, yellow in one, white in the other; and the second pair is the dent in one and the much-wrinkled sweet condition in the other. Let us consider the results when crosses are made. Yellow crossed with white gives a yellow (heterozygote) in the first generation and, if self-pollinated or two such hybrids are crossed, a ratio of ¾ yellow: ¼ white results in the second generation. The cross of a dent corn with sweet corn gives a dent (heterozygous) in the first generation and ¾ dent: ¼ sweet in the second.

When both these characters are in the same cross, the first generation is heterozygous for both pairs of factors, each pair being on a different pair of chromosomes. At reduction division to produce the male gametes the yellow-carrying chromosome may go with the dent or it may go with the sweet-carrying chromosome, thus giving two kinds of gametes—yellow dent and yellow sweet. The white-carrying chromosome may go with the dent or with the sweet-carrying chromosome producing two more kinds of gametes—white dent and white sweet. Thus there may be produced a total of four different kinds of sperms in equal proportions of ¼ : ¼ : ¼ : ¼.

When two such heterozygotes are mated, each kind of male gamete may unite with any one of the four kinds of female gametes for a total of 16 combinations, as illustrated in Figure 25.

Since yellow and dent are dominant, $9/16$ of the plants will produce yellow dent corn; $3/16$ will be yellow sweet; $3/16$ will be white dent; and $1/16$ will be white sweet. The yellow sweet, and white dent are new combinations of the two characters in the original parents. These could be purified and two new varieties established, if desired. As an example of the use of the principles illustrated, in certain cases the yellow character has been transferred to white sweet corn.

VARIATIONS

Nearly everyone has noticed variations in the size and shape of leaves on a tree or a range of shades of color in flowers that supposedly were pure as to variety. The differences between plants, especially between a given plant and its parents, are known as variations. In many cases the variations are due to environmental conditions. For example, where there is a poor spot of soil in a field the corn plants may tassel when much shorter than their normally-growing neighbors. A spot in a field where a strawstack once stood may provide an excess of nitrogen in the soil. This unbalanced condition frequently causes wheat or oats or other grain crops to develop abnormally tall, weak-tissued straw. Such plants are likely to lodge, or become

F_1 MALE GAMETES

F_1 FEMALE GAMETES	$\frac{1}{4}$YD	$\frac{1}{4}$YS	$\frac{1}{4}$WD	$\frac{1}{4}$WS
$\frac{1}{4}$YD	YD YD $\frac{1}{16}$ YELLOW, DENT	YS YD $\frac{1}{16}$ YELLOW, DENT	WD YD $\frac{1}{16}$ YELLOW, DENT	WS YD $\frac{1}{16}$ YELLOW, DENT
$\frac{1}{4}$YS	YD YS $\frac{1}{16}$ YELLOW, SWEET	YS YS $\frac{1}{16}$ YELLOW, SWEET	WD YS $\frac{1}{16}$ YELLOW, DENT	WS YS $\frac{1}{16}$ YELLOW, SWEET
$\frac{1}{4}$WD	YD WD $\frac{1}{16}$ YELLOW, DENT	YS WD $\frac{1}{16}$ YELLOW, DENT	WD WD $\frac{1}{16}$ WHITE, DENT	WS WD $\frac{1}{16}$ WHITE, DENT
$\frac{1}{4}$WS	YD WS $\frac{1}{16}$ YELLOW, DENT	YS WS $\frac{1}{16}$ YELLOW, SWEET	WD WS $\frac{1}{16}$ WHITE, DENT	WS WS $\frac{1}{16}$ WHITE, SWEET

Figure 25. Diagram showing the result of crossing yellow dent with white sweet corn.

prostrate, while the plants in the remainder of the field are upstanding and free from lodging. Certain characters, however, appear to remain fixed and do not change by chance variation. One may be certain that, if one plants oats, they will produce oat plants and not barley. This fixed character of plants is of great significance to agriculture. It is frequently said that varieties "run out." Plant breeders have never found evidence to support this belief. Lower yields can be traced to some change in the environmental conditions, such as reduced fertility, the presence of diseases, weeds, insects, or other evidences of poor farm management.

The variation in crops is principally due to the process of hybridization, or the crossing of plants. The plant breeder who wishes to improve a variety of oats may cross two varieties each of which possesses certain valuable qualities not common to both, with the hope of selecting the plants containing the combinations of good qualities of both parents in the offspring and discarding the undesirable. Many of our present-day crop varieties are the result of such breeding practices. Likewise, the animal breeder makes use of individuals which offer possibilities of combining desired qualities in the progeny.

HETEROSIS, OR HYBRID VIGOR

Many years ago Charles Darwin made the statement that "nature abhors self-fertilization." Modern scientists know that self-fertilization in itself is not undesirable. Self-fertilization, or inbreeding, causes no reduction in vigor, if the genetic constitution of the race is naturally vigorous. For example, oats and barley are normally self-fertilized. Geneticists have observed that the plants developed in the F_1 generation of crosses between two races often were larger and decidedly more vigorous. This effect of increased vigor appears to be correlated with the heterozygotic condition of the offspring. Accordingly, it has been referred to as heterosis, or hybrid vigor. The student should recognize that not all hybrids show heterosis. The degree of heterosis is dependent upon the genetic make-up of the two parents and the manner in which they unite.

Heterosis is an example of size or quantitative inheritance. A character, such as yielding ability, is the result of the interaction of many genes. These are cumulative, that is, they work together and there is partial dominance for each in the F_1. Hybrid vigor, or heterosis, has been placed on a strict Mendelian basis by the hypothesis that each parent furnishes necessary genetic factors for growth and that the F_1 is, therefore, more vigorous in many cases than either parent.

Numerous examples of heterosis are known to breeders. A few examples are the vigor obtained in F_1 crosses of corn, tobacco, poultry, and the well-known cross between the horse and the ass to produce the mule.

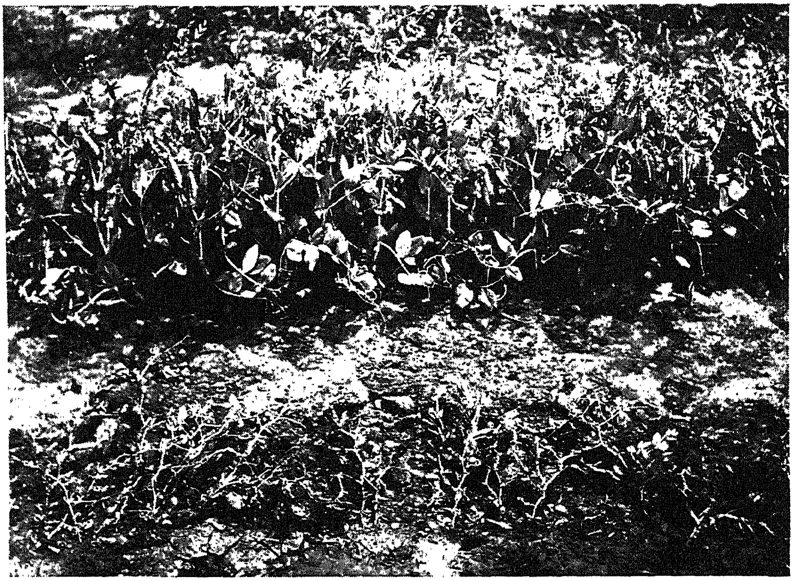

Figure 26. An example of breeding for disease resistance. In foreground, peas susceptible to wilt; in background a wilt-resistant variety.

GENETICS APPLIED TO PLANT BREEDING

Most plant breeders recognize four general methods of applying genetic principles to the improvement of crops: mass selection, pedigree selection, hybridization, and clonal, or bud, selection.

For many centuries agriculturists have practiced the art of mass selection. Some farmers are still following this method when they select seed corn in open-pollinated varieties, although the growing of these varieties is passing rapidly. Such varieties of corn as Reid's Yellow Dent, Leaming, and Boone County White are examples of mass selection that contributed much in our earlier agricultural history.

Pedigree selection was practiced successfully by many breeders for many years. By this method the breeder observed plants in the field and selected them upon the basis of their promising characteristics. The progeny of the selected plants was then placed in test plots for further study as to its ability to yield and to possess other desirable agronomic characters. A few examples of this method are Turkey wheat, Iowa 103 and Gopher oats, and Manchuria barley.

Hybridization is the most important method of improving crops, especially such crops as wheat, oats, and barley. With this method the breeder is able to produce something which did not exist previously. In selection, he is limited by the existing plant types. In hybridization he may take a weak straw, stem-rust-resistant oat variety, and cross it with a strong straw, stem-rust-susceptible variety, to produce a variety which combines the strength of straw of one parent with the disease resistance of the other parent. Many of the important varieties of crops have been produced by this method. Every agricultural experiment station is utilizing the principles involved in the production of improved types through hybridization. Notable examples are Marquis and Newthatch spring wheat, Barbless barley, and Tama and Vicland oats.

Nearly every student has heard of hybrid corn and knows something of its growing importance. The success of hybrid corn is dependent upon the proper combination of two or more inbred lines each of which contributes to the improved progeny. Hybrid corn will be discussed in detail in a later chapter dealing with corn improvement.

Clonal, or bud, selection has been utilized by nurserymen and orchardists in the improvement of ornamentals and fruit crops. Recently the method has received increased attention from the plant breeder in the improvement of grasses. The selection of clones of timothy is an example of this use.

GENETICS APPLIED TO ANIMAL BREEDING

Long before the discovery of genetics breeders of livestock found methods of improvement that were in accord with genetic principles as now understood. The early breeders practiced rigorous selection of the parents and culled the undesirable offspring, methods which are essential in any livestock breeding program. Application of these methods is responsible for the formation of all the breeds of livestock.

The development of the science of genetics has done much to further improve the methods used in livestock breeding. Largely because of genetic concepts, breeders now use more sound methods in selecting breeding stock. While the older breeders selected the breeding animals upon their appearance and performance, the modern breeder evaluates them on the basis of the performance of the progeny. In other words, because of the knowledge of genetics, the modern breeder recognizes that an animal does not necessarily transmit the characters it possesses and that the only means of knowing what an animal will transmit is a study of its progeny. The emphasis that is now placed upon the proven sire and proven dam is testimony to the effect that a knowledge of genetic principles has upon modern breeding practices.

Suggestive Questions

1. What is heredity?
2. What color are the eyes of a baby whose parents both have blue eyes? Brown eyes? Why the differences?
3. What is a gene?
4. Explain the difference between genotype and phenotype.
5. Who was Gregor Mendel?
6. Explain the meaning of dominance and recessiveness.
7. What is meant by the term self-fertilized?
8. What is meant by clonal, or bud, selection?
9. Who was Charles Darwin?
10. What is meant by the F_1 generation?

Suggestive Activities

1. Make lists of sexually and asexually propagated plants.
2. Show by a diagram what happens in succeeding generations when a naturally polled cow is crossed with a horned bull. The polled, or hornless, character is dominant.
3. Examine several types of flowers and locate the male and female parts of each.

CHAPTER VIII

THE IMPROVEMENT OF SMALL GRAINS

From earlier courses the student has learned the importance of the small grain crops to the agriculture of America. Breeding principles are similar for most of the types of small grains grown. Rye, which is normally cross-pollinated, presents problems which differ from those of the self-pollinated plants, such as wheat, oats, and barley. For purposes of simplification of grouping, flax will be considered with the small grains, although, as we have learned previously, it belongs to a different family of plants.

Certain fundamental principles must be considered as basic to an understanding of the methods of improving grain crops. We have already discussed the general bases of genetics and breeding. Now we shall take up the application of the principles as they apply to the small grains. Future farmers are interested in the underlying principles of plant improvement, as such knowledge leads to an understanding of the available varieties, their qualities, defects, and probable usefulness to agriculture.

NEED FOR IMPROVEMENT

One of the questions that may arise in the mind of an alert student is, why improve crop plants? The obvious answer is that the present varieties have certain weaknesses or defects which lower their efficiency of production. Plants, like animals, are beset by a great many diseases. Because of their character and relative value, it is not practical to attempt to treat sick plants. It is true that seed treatment is practiced, as we have learned, but it is largely confined to the prevention of disease, much as one treats a wound or a cut to prevent infection. If it is impractical to treat sick plants, the natural recourse is to grow varieties which are resistant to the prevalent diseases. Such, therefore, are the present efforts. The best means of combatting black stem rust of wheat is to grow a variety of wheat which will resist the attacks of rust. To a greater or lesser extent the same principles apply to other plants and other diseases. Crown rust of oats, smut of cereals, stripe disease of barley, ergot, and pasmo of flax are but a few of the numerous examples.

With the development of better methods of processing food stuffs there is increased interest in quality. More and more the trade demands quality produce and the farmer able to provide the quality is the one who may be expected to profit from his activities. Wheat as wheat alone is not satisfactory. The miller asks how good a loaf of bread it will make. Does it have a satisfactory content of protein? Will the baker be able to produce a maximum number of loaves of bread from each sack of flour? Will the color of the bread be white or will it be so yellow that bleaching agents must be applied to make it satisfactory to the public? The farmer wishes to know whether the variety will yield well, so that he may get the greatest number of bushels. Will the variety of wheat or oats have a strong straw which will withstand lodging and thus permit normal ripening of the grain and prevent the smothering of tender grass or legume plants seeded in the grain? Will the flax seed produced yield a high percentage of oil of a quality desired by the crusher? Will the barley be suitable for malting and thus insure a market premium? These and many other questions are raised. The few listed serve to indicate that the complexity of improvement through breeding may involve the activities of several branches of plant science. The development of Newthatch wheat by the Minnesota Agricultural Experiment Station and the United States Department of Agriculture may be used as an example. The actual crossing and yield testing was done by the plant breeder. He was assisted by the plant pathologist in studies of disease resistance of the new variety. The milling and baking qualities were determined by the cereal chemist. Each science had its part. The improved variety must pass the rigid tests set up by each of the three research groups. It is not uncommon for a variety of wheat to possess yielding ability and yet be very unsuited for the final test, the finished loaf of bread. In the case of winter wheat, the ability of the variety to withstand the rigors of winter is of paramount importance. When all the factors essential for a variety of crops to be classed as acceptable are grouped together, it is evident that the plant breeder has a tremendous task. We shall learn, as we consider some of the successes and failures, how well he is learning to meet these important problems.

MODE OF POLLINATION

The grain crops, as we have learned, may have self- or cross-pollination. With the exception of rye, the normal rule for the small grains to be considered here is self-pollination.

The self-pollinated plant produces its pollen within a closed flower in such a way that the pollen finds its way to the stigma of the ovary and self-fertilization finally results. Varieties of plants normally self-pollinated remain fairly pure and, as the plant breeder often states, they are stable. Barring a small percentage of accidental cross-pollination, the variety may remain for years exactly as it was in its original development.

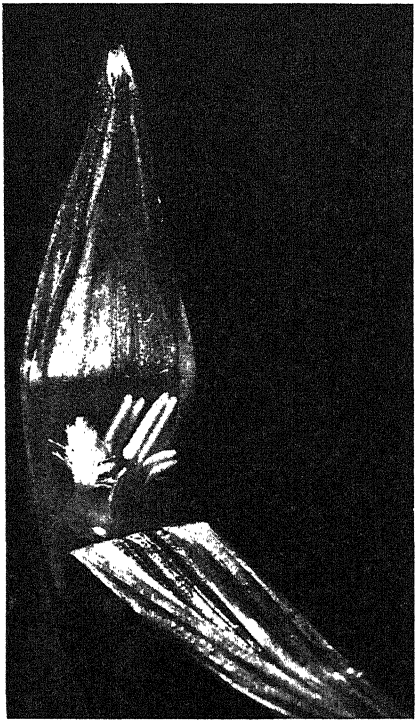

Figure 27. Oat flower with palea pulled back to show three stamens on right and the feathered stigma on the left.

Cross-pollinated crops, as rye, are difficult to maintain in a pure form. Normally the pollen which finds its way to the stigma of the ovary came from another plant. Not infrequently the pollen-producing plant is a different variety from the one fertilized and the natural result is a hybrid individual. The mode of breeding and plan of attack is different for the two groups of plants. First, we shall consider the self-pollinated crops.

THE IMPROVEMENT OF SELF-POLLINATED GRAIN CROPS

The crops having less than four per cent of cross-pollination are considered as normally self-pollinated. The crops included are wheat, oats, barley, flax, rice, tobacco, peas, beans, soybeans, and cowpeas. In the present chapter discussion will be confined to the first four crops listed.

Pure Line Theory. It is desirable here to introduce terminology of value in understanding plant breeding. The great Danish botanist, Johannsen, studied variation in self-fertilized plants and brought forth the pure-line theory. Johannsen, using the common garden bean, a self-fertilized crop, attempted to change the average seed size of the beans by selecting the largest and the smallest seeds from those grown on one plant. He found that the heaviest seeds produced beans which averaged no greater seed weight than those produced on plants grown from the smallest beans. After six years of work, Johannsen found no difference in the descendants of a single plant. He then concluded that common variations due to the environment have no influence upon the following generations. He reasoned that all the descendants of a single self-fertilized plant are alike in their hereditary constitution and environmental effects are not carried over from one generation to the next. The descendants from such a single homozygous, self-fertilized individual were designated as constituting a pure line. Today the plant breeder makes common use of the term pure line. It is evident that a crop like oats, which normally self-fertilizes, tends to remain pure and thus, once it is pure, constitutes a pure line. Likewise, if a normally cross-pollinated plant, such as corn, is prevented from cross-pollination and is self-pollinated, so that its own pollen falls upon the stigmatic surfaces of its own flowers, the result is the same as obtained from normal self-fertilization and the resulting inbred line becomes more and more homozygous until it reaches a pure state, or, as it is called, a pure line. The utilization of these relatively homozygous lines is fundamental in corn breeding as we shall learn when we consider the improvement of corn and such normally cross-pollinated crops as rye.

METHODS OF IMPROVEMENT

The person planning to improve self-fertilized crops has at his disposal three general methods: (1) new introductions, (2) selection, and (3) hybridization. Each of these will be considered in turn.

New Introductions. Bringing in new varieties offers a means of taking advantage of the work of others. In this method breeding improvement, strictly speaking, is not followed. It is important, however, that the breeder become familiar with the possible suitability of existing varieties that may be secured for use in his section. Usually, tests are made of the introduced varieties before they are recommended to the growers of the state. Naturally, states having similar soil and climatic conditions are likely to develop varieties adapted to the conditions prevailing in neighboring sections. In some instances the varieties may be adapted over a wide area. Marquis wheat was developed in Canada, but for many years it was the principal variety of spring wheat grown in the United States. Its adoption by the wheat breeders of America made it possible for our people to grow a valuable variety within a comparatively short time after its release by the Canadian breeders. Nearly every state can give examples of the satisfactory utilization of grain varieties developed by the workers in state agricultural experiment stations other than their own.

The close co-operation that exists between the various agricultural experiment stations and the United States Department of Agriculture leads to a rapid interchange of improved varieties, so that every state has an opportunity to benefit from the work of others. This co-operation has resulted in the wide distribution of certain improved varieties and their rapid distribution to the growers. Most experiment stations secure small lots of seed early in the development of the new variety, so that it may be tested as soon as possible. Naturally, varieties produced by another state should be tested adequately before being accepted as suitable for introduction and distribution to farmers.

Selection. This is one of the most widely-used methods of plant improvement. For many years it was the principal method. Even when varieties are produced by hybridization, selection must be practiced in choosing the best lines resulting from the cross. As considered here, we shall restrict our discussion to the selection as independent of hybridization.

The two general methods of selection are (1) mass selection and (2) individual plant selection. Let us consider the general principles involved.

Mass selection has been followed for years by farmers who selected seed corn from open-pollinated varieties. As the word mass indicates, selection is made from a large group and it may be a rather crude form of selection. As the term is applied to self-pollinated crops, as oats, selection is largely a case of roguing or of selecting individual plants or heads from an existing variety of the crop. The seed of the selected plants is grown and tested for general suitability as to improved yield and other desirable agronomic characters. Although selection has produced many valuable varieties, it is limited in its scope, since one can select only material already existing. If the variety from which the selection is made does not contain superior types, then they can not be selected. Likewise the ability of the breeder to detect the improved types is a very important conditioning factor. Naturally, it is easy to overlook desirable types and failure may result from the inability of the breeder to detect the superior sorts when they appear in the field.

Numerous examples of improvement as a result of selection are available. Among the self-pollinated crops, a few examples are: Victory, Gopher, Iogold, Iowa 103, Iowa 105 oats; Kanred, Harvest Queen, and Blackhull winter wheats; Mindum durum wheat; Haynes Bluestem and Kota spring wheats; Hannchen, Peatland, and Trebi barleys; and most of the open-pollinated corn varieties.

Hybridization. Controlled crossing is a marvelous tool in the hands of a trained plant breeder. As the name implies, varieties are hybridized, or crossed, with the intent of producing new and superior types. By this method the breeder is not limited to that which exists, but is able to strike forward boldly in attempts to produce something which may never have existed. For example, not many years ago no commercial, high-yielding variety of smooth-awn barley existed. There were smooth-awn barleys, but they were of little value from a production standpoint. The Minnesota Agricultural Experiment Station and the United States Department of Agriculture co-operatively produced Velvet, a smooth-awn, high-yielding variety of barley, the first such commercially important variety known to man. While this variety has been replaced to a large extent by superior varieties, its production has led the way, until now smooth-awn barley varieties are known wherever barley is produced. It is probable that no smooth-awn variety of such high-yielding ability would have been developed had we been compelled to depend upon the selection method alone.

The great importance of diseases in an improvement program is known to every farm boy. Those who live in the wheat regions know what can happen when black stem rust moves like a devastating fire through the wheat fields. The plant breeder, co-operating with the plant pathologist, is able to cross varieties, so as to combine disease resistance with yielding ability. In this manner, Thatcher wheat was produced. This variety of spring wheat has been credited with saving the spring wheat industry of the Northwest. In years of severe rust epidemic it was not uncommon to find fields of a susceptible variety of wheat a total failure, when, across the fence, Thatcher wheat produced a normal crop. As we shall see, when we discuss the improvement of specific wheat varieties, other factors of value, such as bread-making qualities, must be considered by the plant breeder.

IMPROVEMENT OF SPECIFIC CROPS

To best understand crop improvement, it will be well to consider the problems of specific crops together with a discussion of important varieties of each. Accordingly, wheat, oats, barley, flax, and rye will be treated in order.

WHEAT

As we have learned previously, there are several species of wheat of economic importance: *Triticum vulgare*, *T. durum*, *T. compactum*, and *T. dicoccum*.

Most of the wheat grown in this country belongs to the *vulgare* species, which includes both winter and spring varieties.

For botany and varieties, see *Agriculture I*, pages 152-158.

The varieties of wheat grown most widely are those which have been found best adapted to yield grain of a quality acceptable to the grain trade. The United States Department of Agriculture, the various agricultural experiment stations, and not a few private breeders are engaged in work leading to the continuous improvement of existing varieties. Through co-operative arrangements new and promising varieties are tested by the various experimental agencies and technological studies are made to determine their suitability. As soon as a variety receives the approval of the research workers, it is distributed by the experiment stations to the farmers of the areas to which it is adapted. In a large measure, the problems of popularizing the variety are in the hands of the agricultural extension services in the different states. The high-school agricultural teachers have their part in the dissemination of information relative to those varieties which may prove advantageous to the community.

Introduction of New Varieties. In the 1936 Yearbook of the United States Department of Agriculture appears this statement:

"More striking than the growth of an oak from an acorn is the fact that the vast Hard Red Spring wheat industry in the

United States, with all the milling, baking, transportation, and trading dependent on it, developed from a few seeds saved from a single wheat plant. The origin of this plant shows how plant breeding cuts across and disregards national boundaries, to develop products useful to all men and nations.

"The variety that founded the hard red spring wheat industry came originally from Galicia, in Poland. From Galicia it went to Germany. From Germany it went to Scotland. From Scotland it went to Canada. From Canada it came to the United States.

"It was David Fife, of Otonabee, Ontario, Canada, who first obtained a small sample of the wheat from a friend in Glasgow, Scotland. He sowed it in the spring, but it proved to be a winter wheat. A single plant of spring wheat developed out of the lot, however, and this was saved and increased. From it descended the wheat that became known throughout Canada as Red Fife. The cultivation of Red Fife wheat in the United States dates from 1860, when J. W. Clark, a Wisconsin farmer, had an excellent crop. The really efficient use of hard red spring wheat, however, had to await the invention of the roller mill and the purifier, which could handle the grain effectively.

"This Red Fife, in turn, became one of the parents of the world-famous Marquis wheat, also developed in Canada by C. E. Saunders. Marquis was a cross between Red Fife and Hard Red Calcutta, and it was introduced into the United States in 1912 by commercial seed and grain firms. Later, after careful testing, it was also introduced by State and Federal workers at experiment stations in several states and it soon became the leading hard red spring wheat in the United States. In 1929 there were still 11¾ million acres sown to Marquis."

The preceding four paragraphs read like fiction. They represent, however, important links in our agricultural history. Today, because of the ravages of black stem rust, Marquis is no longer our leading spring wheat. There is a measure of satisfaction, however, in the fact that it has been replaced in the number one position by one of its "grandchildren"—Newthatch. Thatcher was developed through a double cross involving Marquis as a grandparent. The cross from which Thatcher came was Marquis x Iumillo (a durum) crossed with Marquis x Kanred (a winter wheat). Newthatch was developed by crossing Thatcher with Hope. Other important varieties to which Marquis as a parent has passed on superior characters are Ceres, Hope, Marquillo, Reliance, Sturgeon, Comet, Reward, Canus, Apex, and Renown.

In 1873 a small band of Russian Mennonites left southern Russia for the new world, settling in central Kansas near Newton. As was the custom of those days, they brought with them seed supplies from the homeland. Included was seed of Turkey wheat which they found to be well adapted to the new region. Little attention was paid to the new type of wheat until M. A. Carleton, a cerealist in the United States Department of Agriculture, became impressed with the possibilities of hard red winter wheat in this section. In 1900 Carleton journeyed to Russia to secure new wheat strains. He was responsible for the introduction of Turkey, Kharkof, Crimean, Beloglina, and several other varieties. From this time the hard red winter wheat industry flourished until, today, Kansas produces the major part of our wheat crop. Turkey and Kharkof have long been standards by which other hard red winter wheats are measured.

The introduction of soft red winter wheat antedates that of the wheats previously discussed.

The first wheat grown in America was sown in the Jamestown Colony as early as 1611. Probably this was a soft red winter variety. Mediterranean was imported in 1819 from an unknown port on the Mediterranean seacoast. It has long been an important variety, grown on 2,770,000 acres in 1919. The acreage has decreased greatly in recent years, as superior varieties have been developed.

The durum wheats are of importance in a limited area, as we have seen. Russian settlers in North Dakota introduced Arnautka and thus started durum wheat culture in the state about 1898. In 1900, Carleton brought Kubanka from Russia and is credited with its dissemination. Even today Kubanka is an important variety of durum wheat in America.

The white wheats are grown extensively on the west coast. Baart, a white wheat introduced by the United States Department of Agriculture from Australia in 1900, is the standard used in the study of other white wheats. Federation, another white wheat from Australia, was introduced by the United States Department of Agriculture in 1914.

The list of varieties given above is not complete, but it serves to illustrate the importance of introduction in wheat improvement. While, as a method of improvement, it is not as important as in the past, it has led to great progress in wheat betterment in America. A few of the important varieties developed by wheat breeders follow.

Varieties Developed by Selection. It was not long in our agricultural history until plant breeders began to use selection as an important tool in wheat improvement.

Red May, a soft red winter wheat of importance, was selected by General Harmon in 1830 from wheat grown in Virginia before the Revolutionary War. Fultz, of great importance for years, selected in 1862 from a field of Mediterranean wheat by a farmer named Fultz, occupied nearly 1,500,000 acres in 1929.

C. G. Williams, of the Ohio Station, developed Trumbull as a selection from Fultz. Its yielding ability and resistance to diseases led to the variety's being grown very extensively in the soft red winter wheat section of the country. Other wheats selected by Williams are Gladden, Portage, Fulhio, and Nabob.

H. F. Roberts, a Kansas pioneer wheat breeder, selected Kanred from Crimean introduced by Carleton. This wheat was grown extensively in Kansas, occupying nearly 5 million acres in 1925.

W. M. Hays, an early plant breeder at Minnesota, (later Assistant Secretary of Agriculture) selected two spring wheats destined to attract much attention. These were Haynes Bluestem and Glyndon Fife, both widely grown in the early part of the twentieth century.

Mindum, the leading durum wheat in Minnesota, was selected from a mixed lot of wheat. Its superior characters have led to its being used as a measuring stick for other durum varieties.

Red Rock, a soft red winter wheat of importance, was selected by F. A. Spragg of that station. Nittany, another soft red winter wheat, was selected from Fulcaster by C. F. Noll, of Pennsylvania. T. A. Kiesselbach, of the Nebraska Station, selected Nebraska 60 and Cheyenne, two hard red winter wheat varieties from Turkey. Burnett, of Iowa, developed Iobred, Ioturk, and Iowin by selection. Love, of New York, was responsible for the selection of Forward, a soft red winter wheat, and Honor, a white wheat.

Many other varieties produced by selection could be named, but the preceding illustrate the success of the method and the most important productions.

Varieties Developed by Hybridization. As we have seen, this is the most widely used of present-day methods of improvement. A few of the examples of its success will be given.

As has been stated, Marquis, an early introduction, was produced by hybridization. This variety has led to the production of many more superior varieties.

One of the early successful crosses between wheat species was made by the Minnesota Agricultural Experiment Station in co-operation with the United States Department of Agriculture, when Marquis was crossed with Iumillo, a durum wheat. It was planned to combine the rust resistance of the durum with the grain quality of Marquis. This plan was successful, and the variety was distributed to growers in 1928. It was the first time that a common wheat had been produced from a cross between the two species, *T. vulgare* and *T. durum.*

In 1921, workers in the Minnesota Agricultural Experiment Station, co-operating with the United States Department of Agriculture, realizing that Marquillo possessed certain defects such as a yellow-colored flour, undertook a new series of crosses. They employed two single crosses in making a double cross, thus bringing together a greater combination of desirable factors. As indicated earlier in this chapter, the crosses were as follows:

Marquis x Iumillo = single cross
Marquis x Kanred = single cross

The two single crosses were mated to produce the new variety which possessed the disease resistance of the Iumillo and Kanred grandparents and the agronomic qualities of Marquis.

The new Thatcher wheat was distributed to farmers in 1934. In 1941 it was the leading hard red spring wheat in the Spring Wheat Area, a remarkable demonstration of the improvement of wheat through hybridization. Its susceptibility to leaf rust has led to its replacement by Newthatch.

Another offspring from Marquis was Ceres, produced by crossing Marquis with Kota. This cross was made by L. R. Waldron of the North Dakota Agricultural Experiment Station in 1918. The variety was distributed to growers in 1926. By 1933 it was grown on some 5 million acres in the United States and Canada. The superior characters of Ceres were resistance to stem rust and drouth, high yields, and high quality. During recent years it has proved susceptible to stem rust and its suitability has decreased accordingly.

E. S. McFadden of the United States Department of Agriculture made a successful cross of the species *T. vulgare*, represented by Marquis, and *T. dicoccum*, represented by Yaroslav emmer. He produced two varieties of importance, Hope and H-44. Both are nearly immune to black stem rust and are resistant to leaf rust, bunt, and loose smut. While these varieties have been found to have certain weaknesses that have prevented their wide distribution, they are extremely valuable as parental material to be used in producing improved varieties. The breeders may use them with the view of combining their unusual disease-resistant qualities with wheats which have other desirable agronomic characters. It is hoped that such breeding may lead to the combination of the good qualities of each parent in the offspring.

The production of varieties of wheat capable of growing under the rigorous conditions of winter has been a real problem for plant breeders. When a northern state, such as Minnesota, attempted to grow winter wheat, it was learned that existing varieties were not capable of producing under the conditions of the severe winter climate that prevailed. Accordingly, W. M. Hays and others crossed Turkey with Odessa and, after several years of selecting for winter hardiness, released a variety known as Minturki. This variety has been criticized because it did not possess the most desirable qualities from the viewpoint of the miller. As a result of these deficiencies, Minturki was crossed with Marquis, when a winter-hardy, high-quality wheat variety resulted. This improved variety has been released to farmers under the name of Marmin. It possesses the winter hardiness of its Minturki parent and some of the milling qualities of its Marquis parent, making it more suitable for general adoption.

Many other examples of the production of varieties of all market classes might be given, but those described serve to illustrate the principles and general methods followed in the production of new varieties of wheat by hybridization.

Wheat Breeding. As with all crops, yield is of greatest importance and is conditioned by certain other factors.

Disease resistance probably looms up as one of the major problems before the wheat breeder. The attacks of black stem rust may destroy the entire wheat crop, if only susceptible varieties are grown. Of the diseases, probably breeding for black stem rust resistance has occasioned more work than the other diseases. The smuts, both covered and loose, may cause great damage, especially in the Pacific Northwest. In the areas east of the Rockies, seed treatment may be used to control the smuts. Control by seed treatment is not effective in the Pacific Northwest. Leaf rust may assume great importance when it occurs as an epidemic. Breeders are giving this disease more attention than in earlier years. Scab is another disease of wheat that may cause serious damage in some sections in certain years. Other diseases may cause damage, but those mentioned are the ones most likely to prove damaging to wheat.

Refined technological methods lead to a more careful study of wheat varieties to determine their suitability for milling and

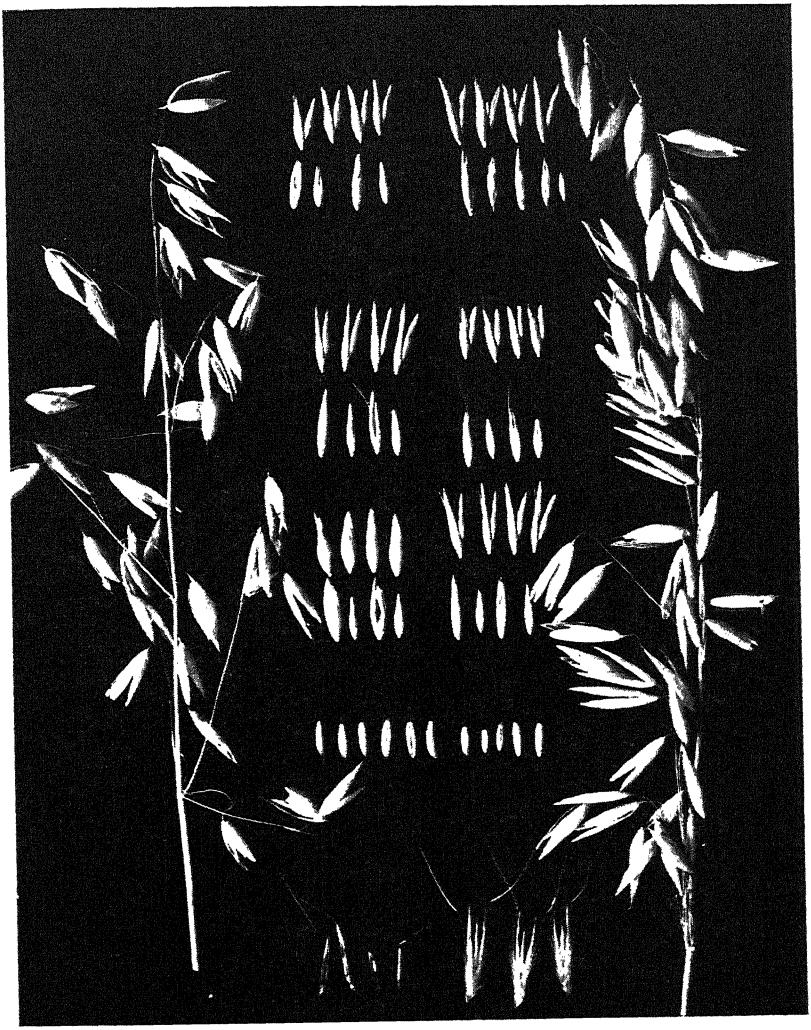

Figure 28. Panicles and florets of different types of oats. On left is an equilateral (spreading or open) panicle; on the right a unilateral (side or horse-mane) panicle. The florets represent primary and secondary grains of different types of oats. At the bottom left are pictured common wild oats *(Avena fatua)*; at the right wild red oats *(A. sterilis)*.

the quality of the final product—the baked loaf of bread. The loaf must have volume, even texture, and but little yellow, which may be avoided by bleaching the flour.

OATS

The oat is one of our most universally-grown crops. While it is very good for human food, the oat has never been of great importance in the American diet. Probably less than 4 per cent of the total production is used for human food and about 96 per cent for other purposes, primarily as feed for livestock.

Like wheat, the oat plant is normally self-pollinated, so that varieties tend to remain relatively pure. The breeding methods for the two crops are very much the same. Each of the methods, introduction, selection, and hybridization is used in oat improvement.

Most of the cultivated oats grown in America belongs to either the *Avena sativa* or *A. byzantina* species. Most of the oats is *A. sativa.* The *byzantina* species is red and is found primarily in the southern states. A limited acreage of hull-less oats (*Avena nuda*) is grown for specialized purposes. Although winter oats may be grown in the South, most farmers seed spring varieties.

Probably more new varieties of oats have been distributed than of any other cereal crop. Not infrequently these so-called varieties are renamed and distributed to a gullible public under the guise of being new and improved varieties. It is to the advantage of the farmer that he be familiar with the good varieties, their values, and defects, so that he may not be misled into the purchase of the many fakes placed on the market.

Introduction. Even today one finds some farmers growing Victory oats, a variety introduced from Sweden many years ago. Other important varieties introduced from Sweden are Swedish Select and Gold Rain. Many experiment stations have found these varieties well suited to the conditions prevailing in their states.

Probably the most important oat introduction into America was the Kherson variety from Russia. The original introduction proved very early, highly productive, and capable of escaping drouth in most seasons. The introduction of the Kherson oat with its earliness led to its rapid expansion in the Corn Belt, where later varieties were unsatisfactory. Breeders have used this oat as a basis for improvement, and many important varieties were selected from the original Kherson introduction. These will be discussed a little later in this chapter.

Other introduced varieties of importance are Banner, brought from Canada, and Green Russian. The latter variety has been grown for years in the north central part of the country. White Russian, or, as it is sometimes called, White Tartar, is a side oat. It has been grown for many years in the northern part of the oat belt. Recently this variety has been used as breeding material, since it possesses considerable resistance to black stem rust, one of the most serious diseases of oats.

Selection in Oat Improvement. This was the principal method for many years. Many of our best oat varieties have resulted from selection.

The Kherson oat, as introduced from Russian, was a gold mine for the oat breeder, as it contained many diverse types. From this oat has come Gopher, a white oat still grown to some extent. Probably this variety is one of the earliest stiff-straw varieties known, which character makes it especially valuable on heavy, fertile corn-land soils, where lodging is a problem. Although it is susceptible to both black stem and crown rust, its earliness often permitted it to escape damage. The Iowa Agricultural Experiment Station has been responsible for great progress in oat improvement by selection. Albion, better known as Iowa 103, and Richland (Iowa 105), Iowar, and Iogold are widely grown selections. Nebraska No. 21 is a white-grained improved type developed by the Nebraska Agricultural Experiment Station. Cole, another selection, was developed by J. S. Cole at the Highmore, South Dakota, Agricultural Experiment Station. State Pride was selected by the Wisconsin Station and proved well suited to conditions in that state.

Fulghum is an important red oat grown in the South. It was selected by J. A. Fulghum from a field of Red Rustproof. From this selection originated all the Fulghum oats grown in America. With its various strains, Fulghum is the most important varietal type of red oats in this country. It was earlier in maturity, more vigorous in growth, and produced a type of grain superior to Red Rustproof. From Fulghum by selection have been developed Alabama Fulghum No. 321, Kanota, Franklin, Frazier, Columbia, and the Coker and Marrett Fulghums.

The preceding examples do not include all oat varieties developed by selection, but serve to illustrate the principles and do include many of the greatest importance.

Oat Improvement by Hybridization. Today, more attention is being given to oat hybridization than ever before. While much progress has been made in the development of varieties resistant to black stem rust until recent times, but little progress had been made in controlling crown rust, a disease which may destroy the oat crop when it occurs as an epidemic. The splendid material available to the oat breeder offers many possibilities. Here the object has been to find varieties possessing certain desirable characters and to combine these into new sorts. Markton, highly resistant to the smuts, has been used widely. Bond, a *byzantina* oat, possesses great resistance to crown rust but is very susceptible to many forms of black stem rust. When such a variety is combined with a stem rust-resistant variety, it is possible to secure a hybrid possessing the desirable qualities of both parents. Victoria, another oat possessing crown rust resistance, has been used in breeding superior varieties. It has been crossed with Richland (Iowa 105) and from this cross have come such promising varieties as Vicland, Tama, and Boone, all resistant to black stem rust, crown rust, and the smuts.

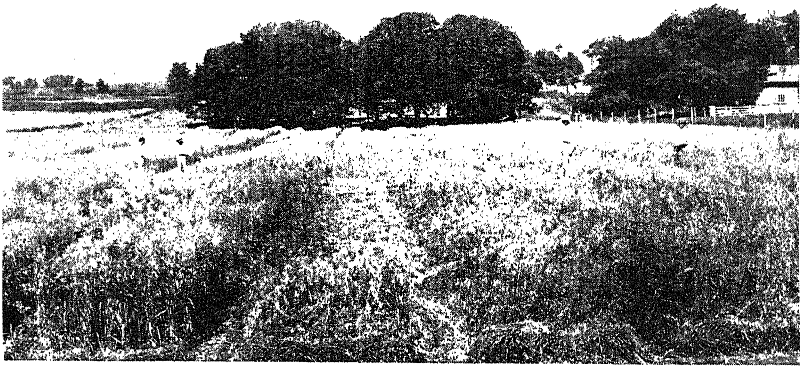

Figure 29. Oat breeding nursery, Ames, Iowa. Note differences in strength of straw as evidenced by varying degrees of lodging.

Minrus, an important oat in Minnesota, was developed by crossing the stem-rust-susceptible Minota with the rust-resistant White Russian. The variety was noted for its earliness, stem-rust resistance, and stiff straw.

An improved hull-less oat resulting from hybridization is Nakota. This variety was the result of a double cross (Markton x Richland) x (Swedish Select x Kilby Hull-less). It is nearly immune to the smuts and is resistant to black stem rust.

The preceding examples are but a few of the many successful hybrids. Rapid progress in oat improvement may be expected to lead to the replacement of most of the old standard varieties within a comparatively few years.

Some of the problems confronting the oat breeder are: earliness, strong straw, thin hull on seed, resistance to the diseases, particularly stem and crown rusts and the smuts, and general all-around yielding ability. Through the use of the superior varieties now available it should be possible to effect combinations which will lead to the desired variety, one possessing a majority of desirable characters. Careful testing to determine disease reaction and all-around worth are necessary activities of the oat breeder. The final and, in some ways, the most critical test comes when the variety is in the hands of the farmer meeting all types of environmental conditions. Should it prove acceptable to the farmer, then the breeder knows that he has developed a superior variety, as he is a severe, but qualified, critic.

BARLEY

Barley production is not as general as oats or wheat. For the most part, barley production is limited to a few states. Where it is grown, however, barley is a very important crop. Although we produce both 2-row and 6-row varieties, we are concerned primarily with the 6-row types, since the former are of little importance in America. Another division is made according to the uses made of the barley, whether it is to be used for feed or for the production of barley malt. Malting barley may be a very valuable cash crop in areas where adapted. Each variety must be considered as to its suitability for feed or malt.

Introduction of Barley Varieties. Probably the most famous barley introductions were Manchuria and Oderbrucker. The first introduction of Manchuria was about 1861, when Herman Grunow, of Miffen, Wisconsin, imported a quantity from Germany. In 1881, the Ontario Agricultural College brought in similar barley and distributed it under the name of Mandscheuri. Since these early introductions, improved strains by selection have replaced the original types. Oderbrucker, a 6-row, rough-awned barley similar to Manchuria, was introduced from Germany shortly after the Civil War. The Ontario Agricultural College imported this variety also and sent a shipment to the Wisconsin

Agricultural Experiment Station. Oderbrucker was distributed widely by the Wisconsin Station and improved selections are being grown by some farmers to this day.

Odessa, a variety much like Manchuria, was brought from Russia to Ottawa, Canada, in 1890. From Ottawa the United States Department of Agriculture obtained a supply of Odessa in 1902 and later distributed it to several state agricultural experiment stations. The South Dakota Station found the variety to be tolerant to summer heat and drouth and distributed it to growers in 1914.

Club Mariout, a barley having a compact, club-shaped head, was introduced by the United States Department of Agriculture in 1903. The variety was grown in Egypt. It has long been an important variety in California.

Coast barley, a 6-rowed, rough-awned, malting type was introduced by early Spanish missionaries from Mexico about 1770. It is believed to have originated in North Africa. Large acreages are grown in California and Colorado.

Although other varieties were introduced, the above-named five were the most important and account for the principal acreage of barley in America for many years. Even today considerable acreage of the Manchuria-Oderbrucker type of barley is being grown in some barley areas.

Selection. Working with the Manchuria and Oderbrucker material, it was evident to early breeders that improvements could be made as the varieties gave evidence of mixed types.

In 1908, the Wisconsin Station released Wisconsin Pedigree No. 5 and Wisconsin Pedigree No. 6, both selections from Oderbrucker. It is said that these two selections constitute the entire Oderbrucker acreage grown today. Notwithstanding the fact that the smooth-awned barleys have grown in favor at a rapid rate, many farmers still grow the old types.

Many selections were made from Manchuria. One of the most important was Minnesota 184, found to be superior in several characters. In Minnesota it practically entirely replaced the old Manchuria barley, but is practically nonexistent now.

Trebi, a 6-row, rough-awned barley of exceptional vigor, was selected by the United States Department of Agriculture and released in 1918. It has been a high-yielding variety but is not grown widely because of its weak straw, disease susceptibility, and poor malting quality. In 1935, however, it was grown on more acres than any other single variety of barley.

Hybridization of Barley. Probably the most significant improvement was the development of the smooth-awned varieties. Comfort was developed by the Minnesota Agricultural Experiment Station in co-operation with the United States Department of Agriculture. It came from the cross of a smooth-awned segregate, Manchuria x Lion crossed on Luth.

Velvet, another smooth-awned, 6-rowed barley was also developed by the Minnesota Station in co-operation with the United States Department of Agriculture. Manchuria was crossed with Lion, a black, smooth-awned barley. Velvet was grown extensively in Minnesota and did much to popularize smooth-awned barleys. For malting it is satisfactory to the trade.

Barbless was developed by the Wisconsin Agricultural Experiment Station from a cross between Wisconsin No. 5 (Oderbrucker) and Lion, a smooth-awned, 6-rowed type of exceptional yielding ability, is the leading variety in the midwest.

Major Problems of Barley Breeding. These include the development of varieties with greater resistance to diseases, particularly the smuts and scab, both of which may do great damage. Weakness of straw is a character to be eliminated, as barley is frequently grown on fairly fertile soils where lodging is likely to occur. A variety which is suitable for livestock feeding and also acceptable to the maltster is to be desired. It is true that environment plays an important part in the production of good malting barley. The tendency to produce satisfactory qualities for malt production is inherited and is eagerly sought by the barley breeder. The farmer is not always certain how he will use the crop produced. It is a decided advantage to be able to shift his plans at harvest time and market the grain for cash if the prices appear more advantageous than feeding it to livestock. And thus we see why a variety that is suitable for both purposes is to be preferred to one grown for malt or feed alone.

FLAX

Flax is not a cereal, but, nevertheless, it is grown primarily for its grain. A small amount of fiber flax is grown in America, but here we shall concern ourselves with the grain types.

Introduction of Flax. Flax is believed to have been introduced by German-Russian immigrants who brought so-called Russian, or common, seed flax to North Dakota prior to 1890. This flax and later introductions by the United States Department of Agriculture have been primarily used for making selections. The introduction of specific varieties has not been general, as was true for wheat, oats, and barley.

Selection. Most of the important varieties of seed flax in America have resulted from plant selection. In 1894, the variety Primost was selected by W. M. Hays at the Minnesota Agricultural Experiment Station. It is believed to be the first pure-line variety of flax produced in the United States.

H. L. Bolley, of the North Dakota Agricultural Experiment Station, has been credited with saving the flax industry. Flax was believed to be "hard on the soil," as it succeeded only on new land. Bolley discovered that yield reduction was due to a disease which he named flax wilt (*Fusarium lini*). By growing his flax in "sick soil" (infested with the disease organism) he was able to select for resistance to disease. From his classic work came North Dakota Resistant No. 114, Buda, and Bison. The latter variety proved popular and became the principal variety of flax grown in the United States. Other varieties of importance developed by selection are Redwing, from the Minnesota Station, and Punjab, a selection from flax introduced from India. The latter selection was made by the United States Department of Agriculture.

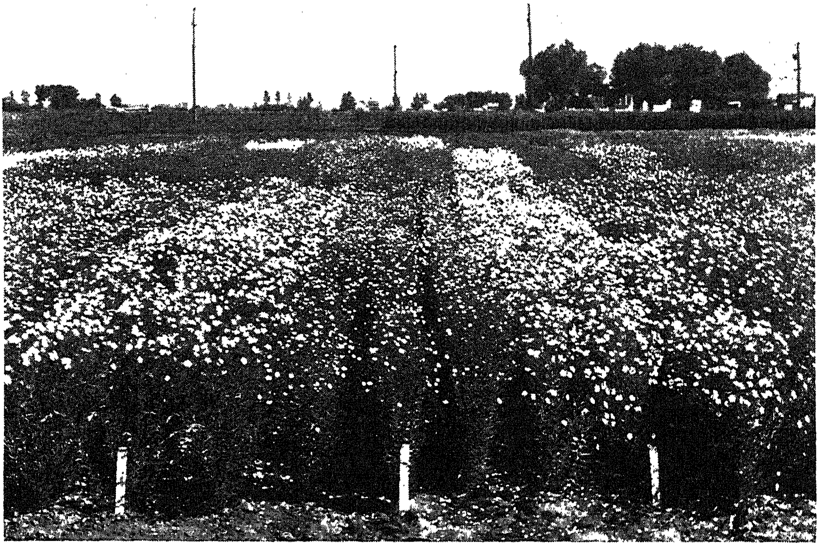

Figure 30. Flax breeding nursery, Bozeman, Montana. Left, selection of Bolley's Golden; center, Bison x 649; right, Bolley's Golden.

Hybridization. In recent years breeders have made more and more use of this method of improvement. Considerable work is under way in North Dakota and Minnesota in co-operation with the United States Department of Agriculture. The work is so recent that few varieties have been tested long enough to determine their suitability. Many lines are in the breeding nursery and may be ready for release within a few years. In 1942, the Minnesota Station, in co-operation with the United States Department of Agriculture, released a new variety, Biwing. This variety resulted from a cross between the large-seeded Bison and the early, small-seeded Redwing. It is believed to be superior to Bison in the quality of oil produced.

Problems to Be Solved. It will be evident to the reader that flax has not been studied as long as most of the grain crops. Accordingly, much remains to be done. The primary problems are to control the various diseases, particularly wilt, rust, and pasmo. As flaxseed is grown for its oil content, a greater oil production is desirable. The linseed oil produced varies in quality. Considerable attention is being given to improving the oil quality through breeding. It is hoped that processors will be willing to purchase flaxseed on the basis of quality, so that the producer of superior flaxseed will be reimbursed accordingly. As with all other grain crops, yield is of paramount importance, as the total bushels produced determine the return to the grower.

HOW CROSSES ARE MADE IN SMALL GRAINS

While it is recognized that most of us will not engage in the hybridization of crop varieties, it is believed that a better understanding of the principles of breeding will follow a discussion of methods used by the plant breeder.

It is important that the student review his botany, so that he may be familiar with the various flower structures and their relationships. Although many breeders make crosses in the field, time may be saved by doing the work in the greenhouse. If done there in the winter, it may be possible to save one year in the total time required to produce a new variety. Although the principles for each of the grains are similar, it will be clearer if each is treated separately.

Wheat. As the wheat flower contains both male and female parts, it is necessary to remove the male parts (anthers) before they produce pollen. The removal is called emasculation. It is important that emasculation be done while the anthers are green but are beginning to turn yellow. The spike is trimmed with small scissors to about 8 or 10 spikelets by removing the upper and lower spikelets. The central florets are removed with fine-pointed forceps. Next, the remaining florets are emasculated by carefully forcing a forceps between the glumes and removing the anthers. A glassine bag about 1½ by 6 inches is placed on the emasculated spike and tied firmly with wrapping twine. A small tag is attached to label the plant. On this tag is placed the name of the female parent (the one from which the male element has been emasculated) and the date of emasculation. Usually, one waits about 2 days to pollinate the emasculated flowers, although the time will vary with weather conditions. From the plant to be used as the male, yellow anthers nearly ready to open are gathered. These anthers are held in the palm of the hand where the warmth will cause them to burst. The glassine bag is removed from the female plant (the emasculated one) and a bursting anther is placed on the stigma of each floret. The bag is replaced and the date of pollination and the number of the male parent are recorded on the tag. The bags are left on the spikes until time for harvest. It is well to set a small bamboo stake to which the plant is attached for support.

Oats. The oat flower is much like that of wheat, except that it is more tender and more likely to be injured in handling. The panicle should be trimmed to about 15 to 20 spikelets. As with wheat, the secondary florets are removed. The anthers are removed carefully and glassine bags about 3½ by 8 inches are used to cover the emasculated flowers. After 3 to 4 days pollen from the male is applied. The other steps are similar to those given for wheat in the preceding paragraph.

Barley. The barley spike does not, as a rule, emerge from the boot until after pollination. For this reason, it is necessary to pull back the leaf sheath and emasculate the flowers. In 6-row barley, the lateral florets are removed and the spike is trimmed to about 12 to 16 florets. Each floret is clipped off just above the tip of the anthers and the exposed anthers are pulled out from above. Bagging, labeling, and pollinating are similar to the methods given for wheat. One to two days after emasculating is the best time to pollinate.

Flax. The flax flower is emasculated before the anthers are mature. Bagging and pollination are done as for wheat. The flowers are usually emasculated late in the afternoon and pollinated the next morning.

Rye. Although rye is normally cross-pollinated, it is crossed in much the same way as wheat. About 16 spikelets are left near the middle of the spike. The awns should be clipped near the lemma, as they may interfere. About 4 to 6 days after emasculation, the pollen may be applied. When ready for pollination, the large, feathery stigma will project from the glumes. Ripe pollen collected in a glassine bag from the pollen parent is dusted on the stigmas by inserting the emasculated spike into the bag.

HOW SELECTIONS ARE MADE AND TESTED

As we have shown, selection has been an important method of breeding. Even where hybrids are made, it is necessary. Here we shall consider the methods generally followed to produce a new variety by selection at a typical experiment station.

First Year. Select about 1,000 heads from individual plants possessing the desired type. The number selected will vary with the crop and the space and funds available for further testing.

Second Year. Plant 25 to 50 seeds from each selected plant in single-plant rows. When the plants are mature, discard all rows which appear undesirable. Undesirable types are eliminated in each successive year as the program progresses.

Third Year. Group or bulk the individuals in the single-plant progeny rows and sow each selection for observation in small plots. Note the uniformity of lines for plant height, date of heading, straw strength, and disease reaction. A separate disease garden may be used for disease studies. Artificial epidemics may be introduced by growing susceptible varieties throughout the plot. Each line should be replicated by growing in three or more locations in the nursery.

Fourth to Sixth Years Inclusive. The number of years required varies according to the nature of the material.

1. Group seed from each replicate from the trials of previous years and grow in single or three-row plots properly replicated.
2. Test duplicate lot in disease garden.
3. Make quality tests, using grain from border rows.
4. Select more desirable lines based upon observations in general for all four years.

Seventh to Ninth Years. Test several of the best lines in replicated rod row or 1/40 acre plots. If possible, make trials in several locations throughout the state.

TESTING THE NEW HYBRIDS

After the harvest of the hybrid seed, the critical stages of determining the worth of possible new developments follow. Having combined certain characters in the hybrid seed, it must be grown, and from the segregating progeny the breeder selects for possible superior true-breeding types.

First Year. Grow 20 to 50 spaced plants. Compare the hybrid plants with the parents to note characteristics.

Second Year. Grow 2,000 to 10,000 singly spaced plants.

Third Year and Later Generations. Grow from 1,000 to 10,000 rows each year from seed of plants selected the previous year. First, select the best-appearing rows and then the most desirable plants within the rows. Place promising lines in special disease nurseries to check on resistance to important diseases. Discard susceptible lines as they become evident.

As soon as the plants appear homozygous, usually 4 to 6 years after the cross, bulk the seed from the homozygous rows. At the Minnesota Station it is common to bulk the lines in the fifth year. Those that are homozygous are selected by examining the individual plants of a line for observable agronomic or disease characters. The plants are harvested and threshed separately. Following an examination of the seed, the homozygous lines are bulked for placing in the larger scale yield trials.

Bulked material is handled as discussed under Selection.

Following adequate testing of the new lines, the workers in various lines, as the breeder, the chemist, and the pathologist, study the data and decide upon the worth of the new variety. If it appears to offer advantages over existing types, it is given a name, and is made available to the farmers of the region.

While many details and steps in the development of varieties have of necessity been omitted, the present treatment illustrates the general problems involved in producing new varieties.

THE IMPROVEMENT OF CROSS-POLLINATED CEREAL CROPS

Unlike wheat, oats, and barley, the cross-pollinated cereals are not so pure as to type and represent a mixture of genetic characters. Also, once a new variety has been developed, it is more difficult to maintain its true genetic constitution, since it is subject to cross-pollination, if grown near other varieties. The average reader will best understand the relative difficulties involved in the maintenance of varieties by comparing the cross-pollinated rye plant with corn.

Our discussion of cross-pollinated cereals will be limited to the rye plant. As we have learned, two general types of rye exist, winter and spring rye. Each is named according to the time of planting. The winter rye is planted in the fall and matures the following summer. Spring rye is treated much the same as spring wheat or oats, being planted in the spring of the year. The winter types are of much greater importance, as but little spring rye is grown.

Due to the lesser importance of rye to our agriculture, not nearly as much breeding has been done with it as with the other small grain crops. Most of the varieties grown were secured as a result of selection. Many of the varieties exhibit a mixture of seed colors which indicate their heterozygous nature. Recently, more attention has been paid to securing varieties pure for seed color. Rosen rye, developed by selection at the Michigan Agricultural Experiment Station, is a conspicuous example of a pure-colored rye variety developed by selection.

The Minnesota Agricultural Experiment Station selected a type from a sample of Swedish rye in 1895. This rye was distributed as Minnesota No. 2 and was an important variety for many years. It is a variety of mixed kernel types.

Dakold, a North Dakota production, originated by selecting rye plants found growing in a field seeded to winter wheat. The wheat had winter-killed and the rye plants had survived. This variety, also of mixed seed color, is one of the most winter-hardy varieties known.

As with the self-pollinated cereals, possibly great opportunity for improvement lies in the hybridization method, but it is not used, because it is necessary to make crosses each year, as is done with hybrid corn. With a crop like rye, the hybrid corn plan does not appear to be economically possible.

The greater hardiness of winter rye over winter wheat varieties has led the plant breeder to strive to cross the two species with a view to combining the winter hardiness of rye with the grain quality of wheat. While the cross may be made, most of the hybrids prove self-sterile and can not be perpetuated. Russian scientists, however, claim to have produced self-fertile types from wheat-rye crosses. It is to be hoped that such a cross may eventually result in a fertile hybrid that will be a real asset to the wheat growers of the nation.

Suggestive Questions

1. From your own experiences what small grain variety characteristics might be improved?
2. Give the mode of pollination of the grain crops.
3. What is the pure-line theory?
4. List the methods of improving self-fertilized crops.
5. How does mass selection differ from individual plant selection?
6. What is a species cross? Give an example.
7. Name three important varieties of oats developed by hybridization.
8. What are the principal problems of the barley breeder?
9. What man is credited with saving the flax industry?
10. Give the steps in crossing two varieties of wheat.

Suggestive Activities

1. Prepare a chart listing all the grain crops grown in your community. Indicate the common mode of pollination of each.
2. Secure wheat, oats, or barley plants at the heading stage. Emasculate the flowers and make a cross as directed in the text.
3. Plan a small grain-test plot on the school grounds or on a near-by farm. Secure seed of leading varieties and plant in rows one rod long and one foot apart to permit cultivation. Label with appropriate stakes and tags. Observe throughout season, recording strength of straw, date of heading, date ripe, and other desirable plant and seed characters.

CHAPTER IX

THE IMPROVEMENT OF CORN

In our discussion of corn *(Zea mays)* we shall confine our study to the dent types, corn and pop, with some treatment of sweet corn. Most of the improvement has been made in these types. Further and in general, the same principles would be involved if one were to undertake improvement of the other types, such as the flints or the flour corns.

For origin and varieties see *Agriculture I*, pages 140-147.

It is believed that cultivated corn originated in South America as a single gene mutation from a wild form of pod corn, and that types of corn originating from crosses between the genera *Zea* and *Tripsacum* were the ancestors of the majority of North American corn varieties.

It is extremely interesting to note that present-day open-pollinated corn is but little different from the corn grown by the Indians when Columbus discovered America. Also, that corn from prehistoric graves and tombs of America, Peru, and Bolivia fails to differ in essential characteristics from present-day types. Until the recently-developed methods of corn improvement, about all that man has done since the discovery of America has been to develop a few dent varieties and to extend their production into areas where such types were believed to be unadapted.

BOTANY OF CORN

The breeder of any plant must first familiarize himself with the botanical characteristics of the plants with which he works. The corn plant is normally cross-pollinated. Ordinarily the plant is monoecious, that is, the stamens and pistils are found in separate flower parts on the same plant. The staminate, or male, flowers are carried on top of the stalk as a panicle, commonly called the tassel. The female, or pistillate, flowers are carried lower on the stalk as spikes emerging from axils of the leaves, usually near the central portion of the plant. Botanically, these flower parts are much like those of cereal plants, such as wheat and oats. The spike-like pistillate flowers following fertilization harden and form the fruit commonly known as the ear.

The pistillate flower develops its style and stigma which constitute the "silk." Pollen grains falling upon the silks develop tubes which pass through the silk until they reach the ovary. Here fertilization occurs upon the union of the male sex cell with the female sex cell, or egg. The pollen tube of the corn is one of the longest pollen tubes known. It emerges from the pollen grain and enters the silk through one of the hairs of the stigma or it may enter the silk directly. When within the silk, it grows rapidly from the food stored in the silk.

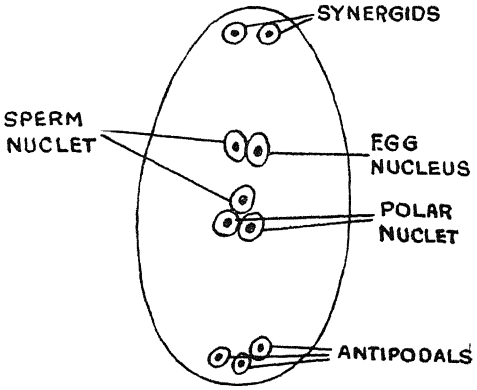

Figure 31. Ovary with its cells illustrating the fusion of one sperm nucleus from the pollen grain with the egg cell to form the embryo and one sperm cell with two polar nuclei from the female to form the endosperm.

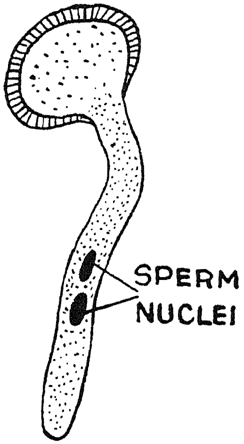

Figure 32. Pollen tube with sperm nuclei which unite with cells of the ovary, resulting in fertilization.

Within the ovary are found several very important cells. By processes of definite divisions there are formed 8 nuclei. The two nuclei formed by the original division move to opposite ends of the enlarging cell and each divides again. At one end of the embryo sac, one of the new nuclei divides to form two additional nuclei known as synergids. The other nucleus divides to form the egg nucleus and one polar nucleus. At the opposite end of the embryo sac at the same time one nucleus has divided to form two antipodal nuclei and the other forms one antipodal and one polar nucleus. The result of these divisions is eight nuclei in all. These are illustrated in Figure 31.

Shortly after the pollen tube starts growth, a cell, known as the generative nucleus, passes from the pollen grain and into the tube. This nucleus divides, forming two sperm cells which pass through the tube to the embryo sac.

As soon as the pollen tube reaches the embryo sac, it penetrates the wall and the tube nucleus, and sperm cells flow into the embryo sac. The sperms move about until they unite with the female cells. One of the sperms comes into contact with the egg cell and the two fuse to form the new embryo. The other nucleus from the pollen grain unites with two of the polar nuclei from the embryo to form the new endosperm. These unions are referred to as fertilizations and, since two fertilizations occur, plants exhibiting these phenomena are said to have double fertilization.

The chromosomes are the carriers of the hereditary factors of both plants and animals. In corn there are 20 chromosomes in each cell. Before fertilization, the number is reduced one half by so-called reduction division. Thus the sperm cell from the male carries but 10 chromosomes. On the other hand, the egg cell of the female also carries a reduced number, or 10 chromosomes. The union of the two cells upon fertilization restores the full normal number of chromosomes, 20. Thus each contributes one half of the chromosomes and, as a result, each is equally responsible for the heredity of the new individual.

The embryo which is formed by the union of the sperm cell from the male and the egg cell of the female is a new generation. It controls the inheritance of future generations, as it is the connection between the past generation and the new.

The endosperm which is formed at the same time is the source of energy for the young embryo. Literally, it is a storehouse of food which keeps the tiny plant alive in storage and feeds it while it is germinating in the soil. In fact, the young plant is dependent upon the endosperm until it has formed roots and green leaves which enable it to manufacture its own food. As will be recalled, the endosperm was formed by the union of one cell from the male and two from the female. Thus the makeup of the endosperm is two thirds from the female and one third from the male. Oftentimes the character and appearance of the endosperm are altered by these fusions, and the character of the endosperm may be very different from that of the embryo. Unusual effects are evidenced in corn as a result of the effects of the pollen parent upon the endosperm character. For example, if the female plant has characters for a white or colorless endosperm and the male, or pollen parent, is yellow, then the endosperm of the developed kernel may carry a yellow color. This visible effect of cross-pollination is known as xenia.

Because of the light weight of corn pollen grains, they may be carried to a considerable distance through the air. For this reason, breeding fields must be isolated from fields of other varieties. Isolation is of considerable importance in the production of hybrids, as will be indicated later.

VARIETIES OF CORN

Due to the normal method of cross-pollination, all varieties have been mixed in genetic character until comparatively recently. Most of the improvement has resulted from mass selection and the progress has been limited. Most of the open-pollinated varieties of importance are listed in Chapter X, *Agriculture I.* Much progress has been made in the replacement of open-pollinated varieties of corn with the hybrid types. In 1941, it was estimated that in the most intensive corn-growing areas more than 95 per cent of the corn grown was hybrid. From the progress made it is not too much to expect that soon all our corn will be of hybrid varieties. Although development has been rapid during the past few years, much tedious work was done before the present methods were adopted. It seems desirable to trace the development of the modern concepts of corn breeding.

METHODS OF BREEDING

Probably the Indian practiced a certain amount of selection in his corn culture and may be credited with having done the first breeding. Whatever credit may be due him, from fossil remains we may be certain that little progress was made in early times.

Mass Selection. This method was probably started by the early grower who tended to reserve the largest and best-appearing ears for his seed supply. Essentially, mass selection consists in the choice of certain desired individuals from the main crop and then planting in bulk the seed harvested from them. It is the plan followed for years by good farmers who made a practice of selecting seed corn in the field.

Many of the early corn breeders were adept at selection. Beyond a doubt they altered the types of corn through their efforts. Although they knew little of the laws of inheritance, they were able to select ears leading to rather definite types. The modern corn breeder knows that too close selection within open-pollinated varieties is likely to result in reduced yields.

One of the most successful of the early breeders of corn was Robert Reid. In 1846, Reid moved from southern Ohio to central Illinois, taking with him a late semi-gourdseed variety known as Gordon Hopkins corn. As he planted his seed late in the spring of 1846, a crop of immature corn resulted. The rather immature corn did not germinate well in 1847, so Mr. Reid replanted the missing hills with a small local variety known as Little Yellow, believed to have been a flinty type of corn. The resulting crop inter-pollinated and from the mixture came the basis for a new variety. After years of selection, James L. Reid, a son of Robert Reid, developed the very important variety known as Reid Yellow Dent, for many years widely grown in the Corn Belt.

One of the earliest cases of mass selection and controlled pollination is the work of A. E. Blount. Mr. Blount started his work with a variety of white corn. He covered 100 to 300 of the best plants with cloth to prevent cross-pollination. These protected plants were hand-pollinated with pollen taken from other desirable plants which were used as males. From this work came a variety known as Blount White Prolific. The Rural New Yorker magazine gave much publicity to this variety about 1879 and was instrumental in its distribution. Even in recent years this variety has been grown by a few farmers in some sections of the South.

The development of the corn show about 1900 added great impetus to the advance of corn selection. Considerable controversy arose over the merits of so-called show-card types of corn. Research workers soon proved that the beautiful ear of corn might be of less value than its rough-looking brother. Following this selection, emphasis was placed upon the plant characteristics, their ability to stand in the field, and their resistance to disease. Careful selection with the plant as a basis was found to be beneficial in leading to varietal improvement.

Ear-to-Row Breeding. The ear-to-row method of corn breeding was an attempt to determine the relative breeding value of different ears of corn by planting a part of the seed from an ear in one row and a part in another row in an effort to overcome the effects of too close inbreeding. As a portion of the ear was planted in a row, that is, an ear to a row, thus originated the name of the method which was followed for several years.

The ear-to-row method was introduced by Hopkins at the Illinois Agricultural Experiment Station when he was attempting to modify the protein and fat content of the corn kernel. The results, as published in 1899, were so promising that the method was adopted by many breeders.

C. G. Williams, of the Ohio Agricultural Experiment Station, presented certain modifications of the method as proposed by Hopkins. Williams planted one half of the seed of each ear in the ear-to-row test. The remnants of the ears were saved. After the ear-to-row trials showed which ears gave the best yields, he chose the remnants of the best and interplanted these, so that there would be free cross-pollination. By co-operating with other workers, he introduced new lines every fourth or fifth year from a grower using the same method. Some of the difficulties of the method are apparent. It was necessary to maintain a yearly plot for the ear-to-row test as well as an isolated plot for crossing the remnants, a multiplication or seed plot, and the general field, a very complicated and detailed plan.

Other modifications of the plan were proposed. The final conclusion of most breeders was that the method offered no significant advantages over the use of a seed plot. With the coming of modern methods, the ear-to-row method has been discarded and is merely of historical interest to the student of today.

MODERN CORN BREEDING

Modern corn breeding is concerned with the use of two methods of breeding, mass selection and selection within inbred lines, for the production of hybrid corn. For the most part hybrid corn has replaced mass selection. Here we shall be concerned primarily with its principles and applications.

Methods. The modern methods of corn breeding date back to 1905, when G. H. Shull began his inbreeding experiments with corn at Cold Spring Harbor, New York. Dr. Shull was interested in the inheritance of the numbers of rows of kernels on the ears as influenced by methods of pollination. Like so many other instances of basic research, he had no idea as to the significance of his work or its application to corn improvement. His experiences serve as admirable examples of the value of pure or basic research as contrasted with research of a practical nature.

At the same time, Dr. E. M. East began inbreeding corn at the Illinois Agricultural Experiment Station. Later in the year he transferred to the Connecticut Agricultural Experiment Station where he continued his investigations. East was interested in studying the effects of inbreeding and outbreeding and, like Shull, did not foresee the tremendous effect the work of each was to exert on corn improvement.

The investigations of Shull and East opened an entirely new viewpoint of corn breeding. The essence of the new concepts may be summarized as follows:

1. The isolation of promising inbred lines breeding true for the characters they possess; 2. the determination of which lines are most productive in crosses; and 3. the utilization of the superior crosses for the commercial production of hybrid corn.

It is of interest to note that hybrid corn has been developed as a result of researches in genetics. It is a splendid example of the application of pure science for the betterment of one of man's most important crops. Probably, because of its scientific basis, there have been much confusion and misunderstanding of hybrid corn and its development. An explanation, as given in the United States Department of Agriculture's Farmers' Bulletin 1744, The What and How of Hybrid Corn, should prove enlightening:

> "Possibly the simplest way to give a general idea of what hybrid corn is, is to compare it to a mule. A corn hybrid, in fact, has many things in common with the mule. A mule is the first-generation hybrid between the mare and the ass and partakes of the better qualities of both parents. It does not reproduce, but must be produced anew each generation for its value in itself, not for reproduction. A corn hybrid is the first-generation hybrid between two strains of corn. Its value is for seed in the production of a crop of commercial corn. This corn will grow, but can not be used for seed without a loss in yield in the succeeding generations. A corn hybrid, then, like the mule, must be produced anew each generation for its value in itself, not for reproduction. During that generation, good hybrids produce larger acre yields of high-quality corn than the best commercial varieties. Finally, neither all mules nor all corn hybrids are efficient."

Objectives. The objective of the breeder of hybrid corn is to reproduce new and improved combinations of desirable characters resulting in plants giving higher yields of quality grain. To accomplish this result it is necessary to eliminate as many weaknesses, such as barren stalks and chlorophyll deficient seedlings, as possible. When these weaknesses have been eliminated, the lines are said to have been purified. The purified lines may then be combined, so that the desirable characters of each may be combined in the offspring, which theoretically should possess the superior qualities of its parents without those undesirable qualities originally found in the open-pollinated varieties. Since corn is naturally cross-pollinated and many of the undesirable characters are carried in a recessive condition, the breeder must resort to controlled pollination. His first step, then, is to practice inbreeding, in the initiation of the program.

Inbreeding. As the name implies, this method consists of breeding the female organs of a plant with its own male pollen. This operation is done by covering the ear shoots with waterproof paper glassine bags before the silks are receptive to pollen. Thus it is possible to prevent cross-pollination. A large kraft bag is placed over the tassel and fastened securely, so that the ripening pollen may be held. At the same time the glassine bag is removed from the ear shoot and the young shoot is cut back by trimming off the silks and one half to three quarters of an inch of the tips of the husks. The glassine bag is replaced. In 24 to 48 hours the silks will have grown out and will be ready for pollination. The large bag is removed from the tassel after shaking the plant to catch all mature pollen. The ear bag is removed and the ripe pollen is dusted over the end of the ear shoot. The ear bag is replaced and fastened firmly to the ear where it remains until the corn is harvested. The necessary tags

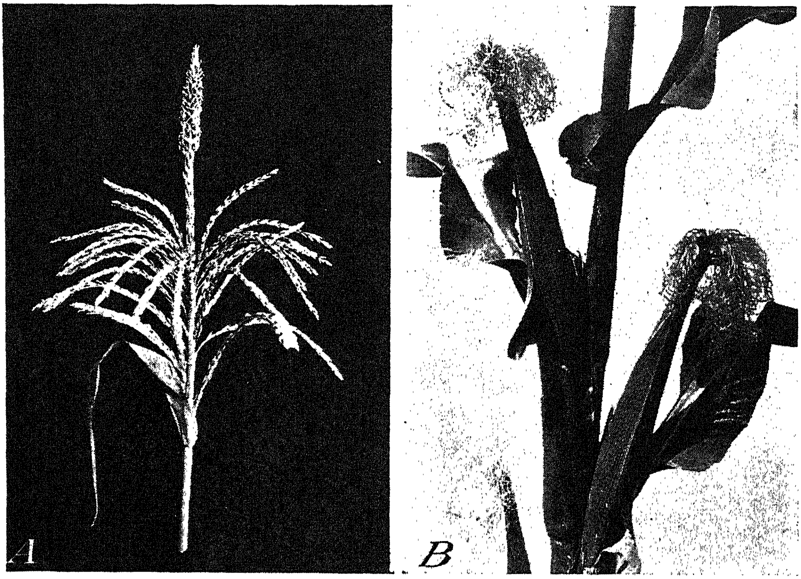

Figure 33. Flowers, or inflorescence, of corn. A, staminate, or male, flowers; B, pistillate, or female, flowers.

and records are made and the operator moves to the next plant. Following fertilization, it is said that the plant has been inbred, that is, it is mated to itself. As every plant is different genetically from every other plant, it is necessary that each one be handled separately.

The development of a satisfactory hybrid requires the production of the best possible inbred lines or strains and their final combinations, so as to result in improvement in yield and other agronomic characters over the original open-pollinated corn.

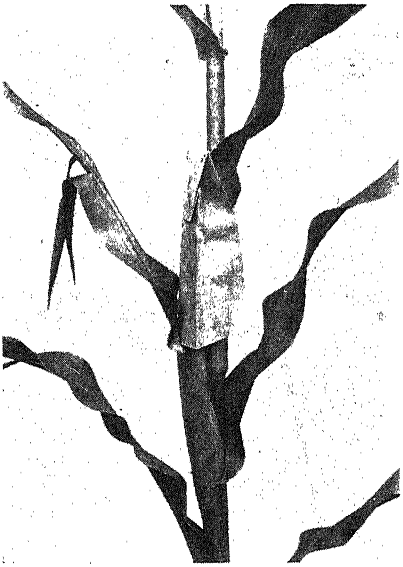

Figure 34. Ear shoot covered with paper bag to prevent pollination. Bag is placed on ear before silks are receptive to pollen.

The inbred seed, as produced within the ear bag, is harvested and stored for the next year's planting. The plants grown from this inbred seed will show greatly reduced vigor and size as a result of the inbreeding. The ears and tassels are bagged and the plants are self-pollinated as before. After about 5 to 7 years of inbreeding the plants will become rather uniform in their characters. Throughout the years the lines with undesirable characters are discarded, as the aim is to end with purified lines of desirable qualities. It has been recently shown that uniformity of yielding ability may be reached earlier, frequently after two years of selfing, thus speeding the improvement program.

Among the thousands of inbred lines produced by corn breeders none has been found that approached ordinary corn in size and yield of plant. Usually, each strain has certain qualities not possessed by others. Some strains produce good ears, others have stiff stalks, excellent root systems, or are resistant to diseases and unfavorable environmental conditions. The job of the corn breeder is to combine the good qualities into one. Thus he develops several inbred lines for test combinations to learn whether the resulting hybrid will carry all the desirable characters. When the two inbred strains are combined by crossing, the better characters of each of the parents tend to be expressed in the first generation, just as the mule possesses much of the size of the horse parent and the endurance of the ass parent.

Once the inbred lines are developed, they breed true and the breeder may carry them year after year as he makes his new hybrid seed. By isolating the inbred lines it is not necessary to use bags and practice hand pollination, reducing greatly the cost of the seed produced. As a rule, such fields should be at least 40 rods from other corn fields. Often the field may be placed in the center of a wooded or pasture area, thus reducing the dangers of chance cross pollination.

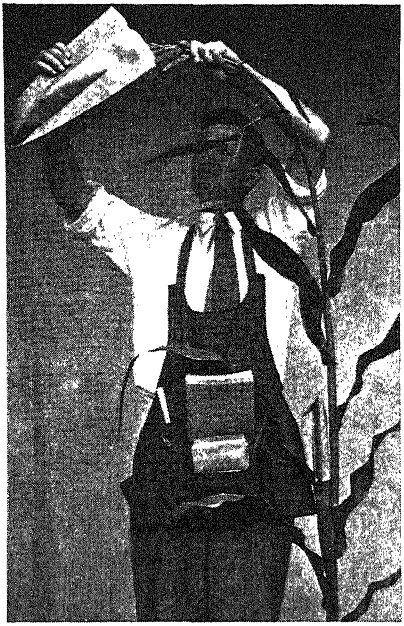

Figure 35. Collecting pollen in bag placed over tassel previous to pollen formation. Note pollinating apron. Worker is Dr. W. Ralph Singleton, Conn. Agric. Experiment Station, New Haven.

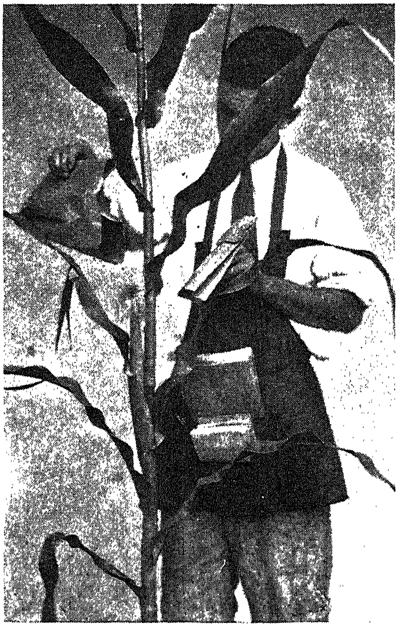

Figure 36. Making hand pollination. Bag has been removed from ear shoot and the pollen in tassel bag is poured upon the silks. After pollination, shoot bag is replaced until ear is harvested.

The modern corn breeder studies the inbred lines carefully. He notes their weaknesses as well as their good qualities and is able to plan combinations which have better than a chance possibility of being superior. Using the modern tools of fundamental research in genetics and chromosome behavior, it is possible to plan a program of attainment. As he can not be certain as to his predictions he must test many lines until he finds the desired combination. The inbred strains which produce poor hybrids are discarded, while those producing the best hybrids are crossed and the combinations are tested thoroughly.

KINDS OF HYBRIDS

There are several methods for combining hybrids. The simplest method is the single cross, a hybrid between two inbred lines. When three inbred lines are involved in a cross, it is a three-way cross. Four strains are frequently combined to form a double cross. Another combination is the top cross which involves crossing an inbred line with an open-pollinated variety. Each type of cross has advantages lending its use to the corn-improvement work.

Single Crosses. Single crosses are hybrids between two lines. The breeder often uses letters or numbers to indicate the parents. The female is usually designated first as it is crossed by the male. Thus B x A would mean that B, the female, was crossed by A, the male. Since the inbred lines are reduced in vigor, the plants and the hybrid ears produced will be small. The seed produced on the female is hybrid seed to be used for planting the commercial crop. The single cross may be designated as B x A.

The single cross has the disadvantage of giving a low yield of seed and thus increases the cost of production. The irregular size and shape of the kernels tend to make planting with regular farm equipment difficult. It is true that the single crosses produce the most uniform plants and ears of any of the types of hybrids. For this reason, they are of special value when uniformity is desirable. In sweet corn for canning the advantages of uniformity are great. Accordingly, sweet-corn growers favor single crosses in producing the commercial crop.

The Three-Way Cross. This cross is made by crossing the hybrid of a single cross with a third inbred strain. Thus the characters of three inbred lines are in the resulting hybrid. It may be designated as (B x A) x C. The single cross is grown from hybrid seed and will produce a large plant with more nearly normal-sized ears. When it is used as the female, as is commonly done, a larger yield of well-shaped kernels usually results, as contrasted with the single cross. The combination of three inbred lines also offers better opportunity for the combination of a greater number of desirable growth factors, although it is primarily valuable because the parents yield well.

The three-way cross probably has no especial advantage over the double cross. Some breeders believe the three-way cross to be somewhat more uniform than the double cross, but differences are small and probably not of great importance. The principal disadvantage in the use of three-way crosses is that an inbred strain must be depended upon for the pollen needed for the cross. Some valuable three-way crosses have been developed. Minhybrid 301, a product of the Minnesota Agricultural Experiment Station, is a three-way cross that has been very successful in the northern part of the Corn Belt.

Double Crosses. The double cross is somewhat like the three-way cross except that two single crosses are combined. For example, B x A, one single cross is combined with C x D, a second single cross. Here both parents resulting from the single crosses are vigorous and an abundance of high quality seed may be expected. The resulting hybrid (B x A) x (C x D) is used for seed. This method is used by many corn breeders, as it gives a very fine yield of quality seed because the vigorous plants usually produce an abundance of pollen.

The Top Cross. This cross has not been used as extensively as the other methods. A promising single cross (B x A) is combined with a good open-pollinated variety. The principal advantage of the top crosses lies in the greater ease of locating one inbred that will combine well with some standard variety than it is to locate 3 or 4 inbreds to be used in a three-way or double cross. The modern plant breeder can make good use of the top cross in making preliminary tests of inbred strains which may be utilized in various hybrid combinations. Such tests may save considerable time in making possible an earlier evaluation of the inbreds that are used.

PRODUCING HYBRID CORN

A diagrammatic illustration of the double cross is given in Figures 37 and 38. Each ear labeled B, A, C, and D is from an inbred parental line. If these ears are inbred, they will produce ears like those illustrated year after year. When plants from seed of B are pollinated with pollen from the plant produced by A, the single cross B x A results, as is illustrated below its parent. In the same manner the single cross C x D is produced from seed on ear C pollinated by pollen from plants producing D ears. The ears on the B x A plants, pollinated by C x D plants, give the first generation seed of the double cross (B x A) x (C x D) for use in growing the farmer's commercial corn crop.

The student must guard against confusing the generation of the plant with that of the ear. It must be remembered that the seed produced is one generation in advance of the plant upon which it is borne. For example, if one grows two inbred lines A and B and crosses one upon the other, as taking pollen from the tassel of B and applying it to the silks of A, one does not change the constitution of plant A. It still remains an inbred plant. The seed produced following fertilization is hybrid seed. It is neither B nor A but is a combination of the two inbred lines. As a rule, in all outward respects it appears to be the same as inbred seed, except when xenia occurs, as has been discussed. Then, when the harvested seed is planted, it produces a hybrid plant. Again, in turn, the seed produced by the hybrid plant will possess the visible characteristics of the hybrid but genetically will be one generation in advance of the parents. If the farmer plants this seed, it will soon segregate, resulting in the splitting of the desirable growth factors which were combined in the hybrid, and many of the advantages of the hybrid will be lost. If continued selection is made within succeeding generations, the lines will tend to return to the level of the original material used in producing the inbreds. If close selection is followed, yields may fall below those of the original parents. If seed is selected from the commercial crop, the yield may be expected to decrease from 10 to 25 per cent in comparison with the yield of the double cross, illustrating why it is necessary to make the hybrids each year to keep the greatest number of desirable growth factors in combination.

Since the combination of inbred lines must be made each year, it is necessary to maintain the inbred lines in a pure state, so that they may be ready for the crossing plot as needed.

PRODUCING HYBRID SEED CORN

Since its modest beginning early in the Twentieth Century, the hybrid-corn business has grown at a very rapid rate during recent years. Large corporations have entered the field of plant breeding. These organizations have recognized the need for a scientific approach to the problems of hybrid corn and are staffed with trained and experienced plant breeders, geneticists, and pathologists. In many cases these men were successful scientists in state and federal research laboratories before entering the commercial fields.

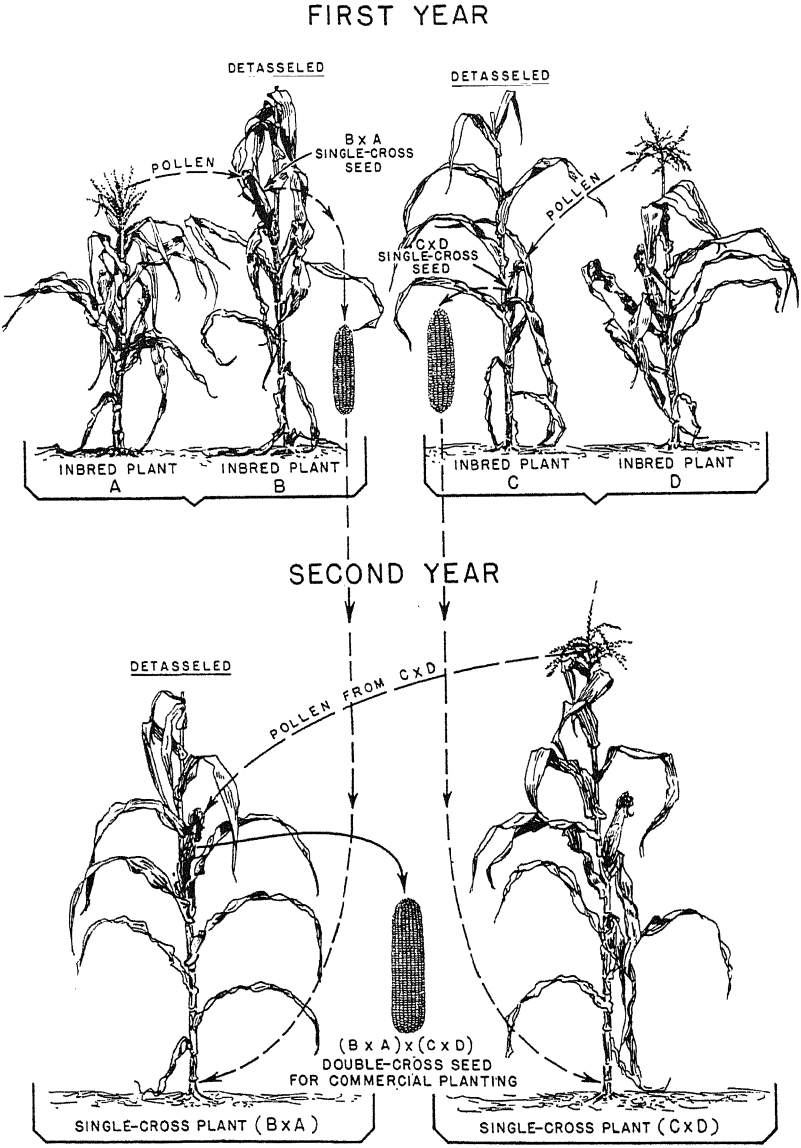

Figure 37. Diagram of method of crossing inbred plants and the resulting single crosses to produce double-cross hybrid seed.

Many small growers entered the hybrid seed-corn business, but many were forced out as a result of competition. The large company with its huge organization is able to produce seed at a cost far below that of the isolated individual. The use of large-scale machinery, drying, and storage equipment, and the efficient work of distribution by large sales organizations is certain to reduce unit costs of production and to result in greater centralization of the hybrid-corn business. Many farmers who have planned to produce their own hybrid seed are finding that it is better business for them to depend upon the specialist to provide their seed supplies. Not a few farmers have engaged in the production of hybrid corn and some will undoubtedly continue. In Minnesota the Minhybrid Seed Corn Growers Association is an example of effective cooperation among farmer producers of hybrid seed corn. In this state the inbred lines are controlled by the state experiment station, and the producer purchases these lines for making the hybrids. He then has full title to the hybrid seed produced but must return to the experiment station to secure new seed of the single cross parents. The Wisconsin and North Dakota Experiment Stations follow a plan similar to that of the Minnesota Station.

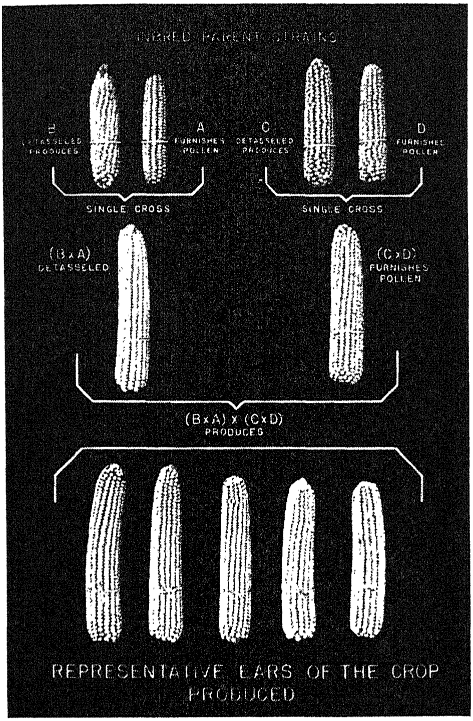

Figure 38. An illustration of inbred ears and the result of making single and double crosses.

There is nothing to bar the enterprising farmer from producing his own inbred lines and hybrids, and, in a few cases, he has done so. It is probable that few farmers will wish to enter this business but will find it more economical to secure their seed supplies from larger producers.

To produce hybrid corn, one must first develop or purchase inbred lines. These are produced by inbreeding, as indicated previously in this chapter. Assuming that the inbred lines are available and that their suitability for specific combinations is known, the breeder is ready to make the hybrid.

It is necessary that an isolated field be located to prevent chance cross-pollination. It is best that this field be at least 40 rods from another field of corn, unless there are natural barriers as buildings or trees between the fields of corn. As a rule from 2 to 4 rows of the female parent are planted to every row of the male parent. The number will vary with the vigor of the male parent. If an inbred male parent is used, probably only 2 rows of the female will be grown. If double crosses are made, then both the male and the female will be vigorous. It should be possible to use 4 rows of the female to 1 row of the male. Such a crossing field is illustrated above. The proper ratio is maintained by careful planting. A diagram of the field may aid in preventing errors.

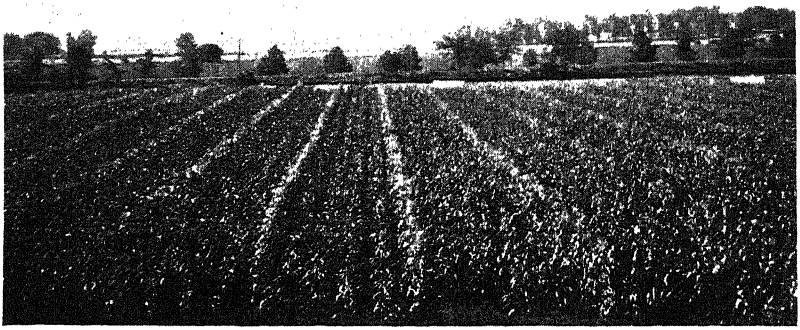

Figure 39. A crossing field of hybrid corn. Four rows are detasseled to each row not detasseled. The one row furnishes pollen for the four detasseled rows. All ears produced on the detasseled rows will be hybrids.

Since the corn plants carry both male and female flowers, it is necessary to remove the male flowers from the plants to be used to produce the hybrid seed. Accordingly, during the entire blossoming season, the grower must go through the field to remove all tassels before any pollen is produced. During the height of the growing season it is necessary to check the plants every day. Later, the interval may be extended. It is necessary that all tassels be removed else self-pollination may occur. The tassels arising from the suckers must not be overlooked. Tassels are readily removed by giving them a quick upward pull. Care should be taken to avoid removing the upper leaves, so as not to cause injury to the plant.

Although the inbred strains of corn may be produced in isolated fields, this practice is not always followed, as it is much easier to maintain purity when hand pollinations are made.

WHY GROW HYBRID CORN

This is a question that few farmers raise. The success of hybrid corn has been so great that even the most skeptical are becoming convinced. Many hybrids produce from 15 to 20 per cent more grain than the available open-pollinated varieties. The cost of producing a 75-bushel crop of corn is but little more than the cost of producing a 65-bushel crop. The better hybrids also have the advantage of earlier maturity, a factor of great importance in the northern part of the Corn Belt. As a rule, hybrid corn produces a higher percentage of marketable seed and thus, bushel for bushel, is worth more to the producer. More and more attention is being given to the production of hybrids resistant to diseases and possessed of desirable plant characters, such as extensive root systems and strong stalks.

Many farmers were slow to adopt hybrid corn, because of its higher seed cost. When one considers that a bushel of seed corn will plant from 6 to 9 acres, it is evident that the slightly higher seed costs are too insufficient to warrant any grower in growing lower yielding, open-pollinated varieties. Several of the states conduct extensive corn-yield trials in various sections. These trials serve to determine the suitability of the various hybrids to the different parts of the state. The up-to-date farmer may visit these demonstration fields and see for himself just what he may expect from hybrid corn. The state agricultural experiment stations can furnish accurate records of performance as guides to the farmer who is interested in hybrids. Following these leads, a farmer may secure a few bushels of hybrid corn and test it out in comparison with his own variety. If he finds a satisfactory hybrid, then he may wish to expand his acreage.

It is not improbable that practically all our commercial corn acreage will be planted to hybrid varieties within the relatively near future as each state develops adapted hybrids.

SWEET CORN HYBRIDS

The sweet-corn canning industry is confined to relatively few states, and sweet corn, as a field crop, is not of as great importance as field corn. As a garden crop, sweet corn is widely distributed, with most of it being marketed in tin cans.

Most of the sweet corn grown for canning is produced under a contract between the grower and the canner. As a rule, the canner determines the variety to be grown. Recognizing the advantages of the hybrid varieties, many of the canning companies have naturally given them preference.

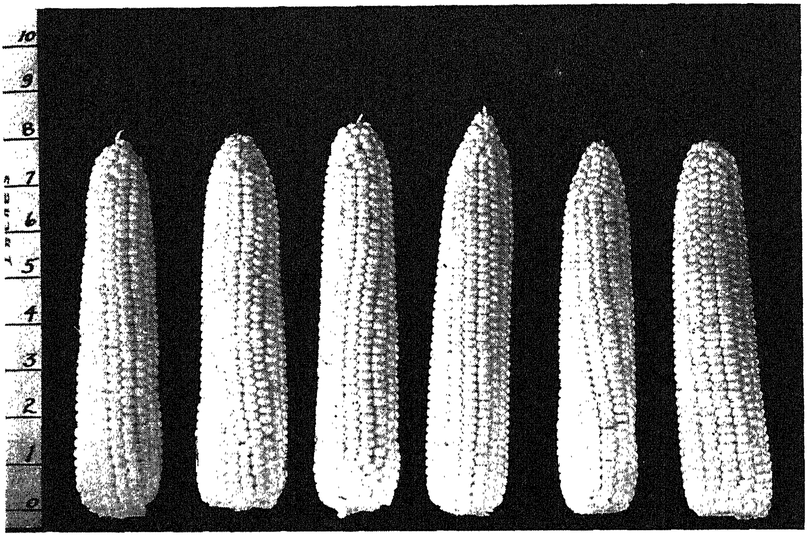

Figure 40. Lincoln, a hybrid sweet corn, developed by the Connecticut Agricultural Experiment Station. This hybrid received the Bronze Medal in the All America trials in 1941. This was the highest award to any sweet corn variety.

Hybrid sweet corn was of little importance in America until the introduction of Golden Cross Bantam in 1932. It is a hybrid between Purdue 39, an inbred of unknown parentage, and Purdue 51, a Golden Bantam inbred. Golden Cross Bantam was produced by the Indiana Agricultural Experiment Station and the United States Department of Agriculture. Three years after its introduction this variety was grown widely with more than one million pounds of hybrid seed produced.

The Connecticut Agricultural Experiment Station is credited with being the first station to make extensive use of sweet corn hybrids in raising the general level of production.

This station has classified its hybrids into maturity seasons as follows: Extra Early, Early, Early Midseason, Midseason, Late Midseason, Late, and Very Late. The average period between the seasons is about three to four days. These varieties permit the grower to have available a supply of sweet corn throughout the entire summer.

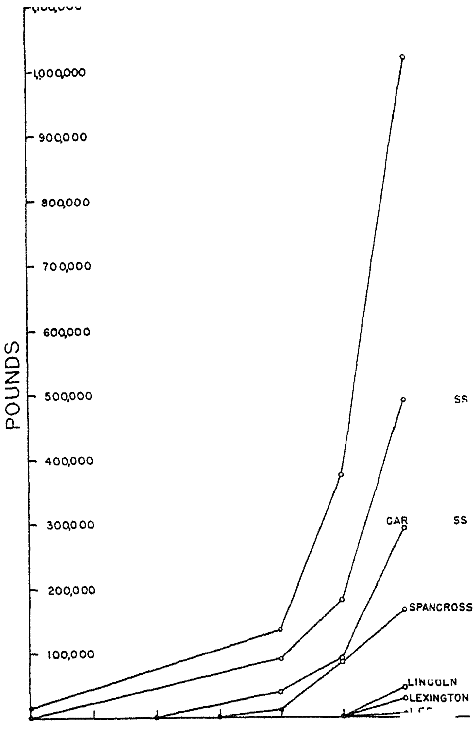

Figure 41. Seed production of Connecticut Experiment Station hybrids, 1935-1941. No survey made in 1936, 1937 and 1938.

Some of the important varieties of sweet corn developed by the Connecticut Station are Spancross, Marcross, Lexington Carmelcross, Lincoln, Lee, Golden Cross Bantam, Wilson, and Golden Stowells.

Most of the successful sweet corn hybrids are single crosses. The uniformity resulting is one of the great advantages of hybrid sweet corn. The uniformity results in a higher percentage of satisfactory ears. In careful trials it has been possible to secure as much as 50 per cent increased yield of cut corn over the ordinary open-pollinated variety.

Yield of cut corn is but one of the factors improved. Careful tests have resulted in improved quality of product. The recommended hybrids have more tender seed coats, which make the grain much more palatable. Not only are the kernels more tender, but they possess a more pleasing flavor and a greater degree of sweetness.

It may be expected that even greater progress may be made in sweet corn improvement. With more intensive study we may expect improved quality of product as well as greater resistance to diseases, insects, drouth, and other unfavorable environmental factors which tend to lower production.

Several of the sweet-corn canning companies maintain research staffs. These men devote considerable time to the breeding and testing of improved varieties of sweet corn.

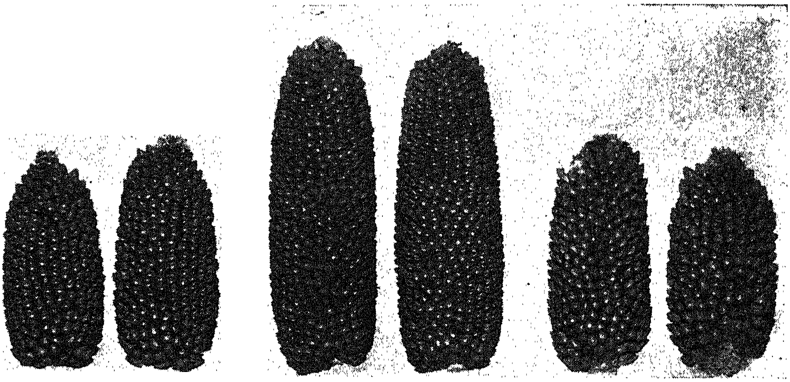

Figure 42. Minhybrid 250 popcorn. On left and right the inbred parents C-1 and C-6; in center the resulting hybrid.

POPCORN

Popcorn, as well as field or sweet corn, may be improved. Intensive production of popcorn is even more limited than that of sweet corn. The work that has been done shows that much progress may result within a comparatively short time after the initiation of the improvement program.

The grower of commercial popcorn desires a high-yielding type. The consumer of popcorn desires a high-quality product. The job of the breeder is to combine the two requirements in so far as possible. It is recognized that the large types of popcorn yield popped grains of lower quality than the smaller so-called hull-less types so popular with the consumer.

A late-maturing yellow popcorn known as South American Yellow has been popular because of the large volume of the popped kernel and its creamy color, but it is not as tender as the Japanese Hull-less popcorn.

The Minnesota Agricultural Experiment Station began the inbreeding of Japanese Hull-less popcorn in 1925, and single crosses of the inbreds were made in 1930. From the various hybrids tested, the Minnesota Station has released a superior single cross, Minhybrid 250. This variety has not only yielded more than the original Japanese Hull-less but it has given more than 5 per cent greater volume of popped grains, as measured by popping expansion. Popping expansion is determined by popping a measured quantity of grain and computing the percentage increase in volume.

It appears reasonable to state that popcorn or any of the other corn species may be improved through inbreeding and subsequent recombination in much the same way that has been successfully demonstrated with the dent species.

Suggestive Questions

1. Where did corn originate?
2. Differentiate between a staminate and a pistillate flower.
3. What is the meaning of double-fertilization?
4. What is xenia?
5. Why are chromosomes important?
6. What two men were primarily responsible for hybrid corn?
7. Explain how hybrid corn is similar to a mule.
8. What is a single cross? A double cross? A three-way cross?
9. When is a top cross used?
10. Why is hybrid corn especially valuable to the canner?

Suggestive Activities

1. Plant one hill of corn in an isolated spot. Observe the lack of development of grain. Explain.
2. Visit hybrid corn fields. Take notes on plant characteristics. If possible, contrast with the characteristics of corn grown in an open-pollinated field.
3. Lay out a diagram of plans for the fields to produce hybrid corn on your home farm.
4. Visit fields of different hybrids and open-pollinated varieties. Note maturity differences and explain.
5. Get fresh flowers from a corn plant. Examine both the male and female parts and diagram their relationships.

CHAPTER X

THE IMPROVEMENT OF GRASSES

Almost every farm boy appreciates the importance of plant breeding in the development of new and better varieties of corn, wheat, oats, and other grain crops. The agricultural papers have carried much information about hybrid corn, its value, and importance to agriculture. Few of our agricultural people, however, have an appreciation of the importance of the forage grasses and the possibilities of their improvement through breeding. Nearly every farmer has a pasture area, frequently on a part of the farm where soil fertility is low and there is little or no possibility of growing grain crops. As a result, too many farmers associate pastures with poor lands and have little conception of their possible value in a system of permanent agriculture, the objective of every good farmer.

In European countries, especially in England and Scotland, the farmers have long regarded pasture and forage crops as of equal importance with the grains. As a result, we find in England and Scotland some of the best pastures and meadows in the World. In these same countries considerable attention has been given to the problems of improvement.

It is only within recent years that much work has been done in grass breeding. With the exception of timothy, little breeding has been done in America. Rapid progress, however, is now being made as the fundamental principles of genetics are utilized in intensive research programs. Many state agricultural experiment stations and the United States Department of Agriculture are engaged in the active breeding of grass crops.

WORKERS IN GRASS IMPROVEMENT

Some of the foreign countries have done much more work in grass improvement than the United States has. The work with grasses is outstanding in the British Isles, New Zealand, Australia, Sweden, Germany, and Denmark.

Without doubt the greatest work in herbage grasses has been done at the Imperial Bureau of Plant Genetics, Aberystwyth, Wales, under the leadership of R. F. Stapledon and his associates.

New and more attention has been paid to grass improvement in the United States and Canada. The locations of the grass-breeding stations are shown on the map in Figure 43.

The student should appreciate that grass-improvement work in this country is largely in its infancy. It has not been pursued as long or as intensively as it has been for small-grain and corn breeding. As a result not nearly as much is known regarding methods of breeding or programs of attack.

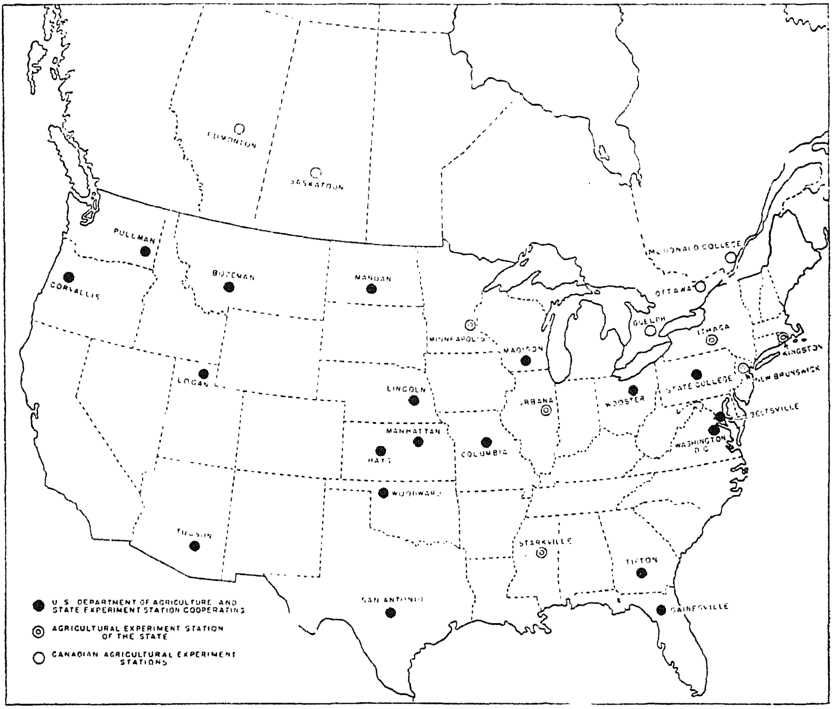

Figure 43. Location of experiment stations in the United States and Canada where organized grass-breeding work is in progress.

The best we can hope to do in a treatment of grass improvement is to point out the general situation, the progress that has been made, and the problems that remain to be solved.

IMPORTANT GRASSES OF AMERICA

Before discussing methods of improvement, we shall first consider the types of grasses, their adaptation, and their relative importance in American Agriculture. For a proper understanding of the distribution of the grasses and their relative importance the areas for the various groups are illustrated in Figure 44. Both native and introduced grasses contribute much to our agriculture. Many of the introduced grasses have proved so successful that often the public believes them to be native. Kentucky bluegrass and timothy are examples of introduced grasses that are accepted so universally in the northeastern section of the United States that they serve as well as though they were native to the region.

The term native, as used in the map of the grasslands of the United States, is restricted to those grasses that were found growing here when the country was discovered. The limits of the areas, as defined, are not exact by any means, as there is considerable overlapping due to the fluctuating environmental conditions existing in any one section of the country.

NEED FOR IMPROVEMENT

One may ask, Why bother to breed the grasses? Are they not satisfactory? To these questions the answers are no. The grasses are not completely satisfactory. We should breed them to produce types of higher-yielding ability that will provide more palatable, nutritious forage.

Some 60 per cent of the total land area of the United States is used for grazing at least a part of the year. By far the larger portion of this grazing area is covered with grasses. If one adds the hay from grasses to the pasturage, it is estimated that nearly 43 per cent of the feed of farm livestock comes from the grasses. Does not this fact in itself impel us to consider grass improvement important?

Grasses must be credited with great benefit in their control of erosion, both by water and wind. It is to be hoped that our farmers have learned their lesson and that never again will we destroy valuable grass cover in areas subject to erosion.

Grasses are of value in other respects than as feed for livestock. They are used for the beautification of lawns, boulevards, parks, cemeteries, and golf courses. The qualities thus required must be included as no small part of a breeding program. It has been estimated that more than 100 million dollars are spent annually for these nonagricultural purposes.

In recent years, as more attention has been given to the problems of grasses, it has become more evident that they are subject to diseases the same as their more aristocratic relatives, the grain crops. So little has been done to improve them that the surface has not been scratched. Many foreign workers, especially in England, have accomplished much. Is there any reason that similar improvements may not be made in America?

The locale, adaptability, and characteristics of the most common grasses have been presented in *Agriculture I*, *Agriculture II*, and *Agriculture III*. We shall limit reference to them again only in so far as some phase of breeding or improvement may have application to the present discussion.

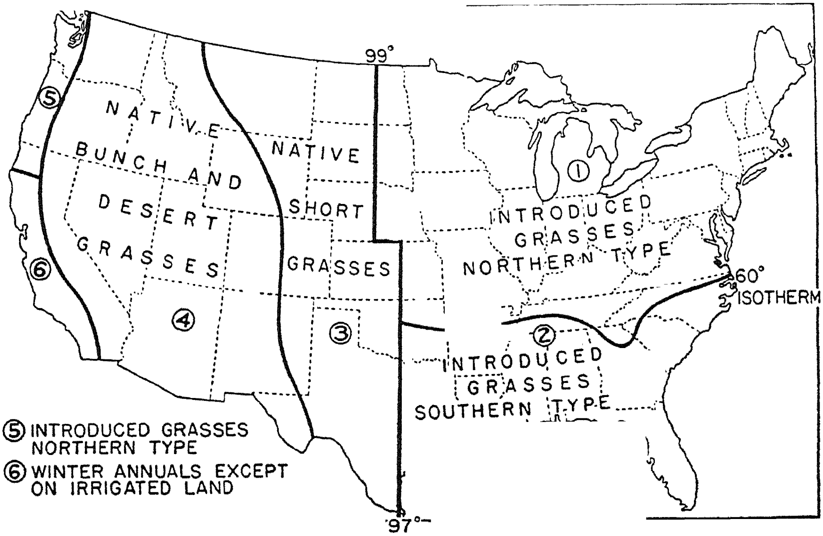
99°
NATIVE BUNCH AND DESERT GRASSES
NATIVE SHORT GRASSES
INTRODUCED GRASSES NORTHERN TYPE
60° ISOTHERM
INTRODUCED GRASSES SOUTHERN TYPE
①
②
③
④
⑤
⑥
⑤ INTRODUCED GRASSES NORTHERN TYPE
⑥ WINTER ANNUALS EXCEPT ON IRRIGATED LAND
97°

Figure 44. Map showing the regions of native and introduced grasses in the United States.

Comparatively little attention has been given to the improvement of the hay and pasture grasses. All possess certain weaknesses which might be remedied through a program of plant breeding planned to meet specific needs.

Not all the grass species can be considered here. Those which are most widespread and valuable will naturally stimulate the most attention. Often the principles involved in the improvement of one species will apply to other related types.

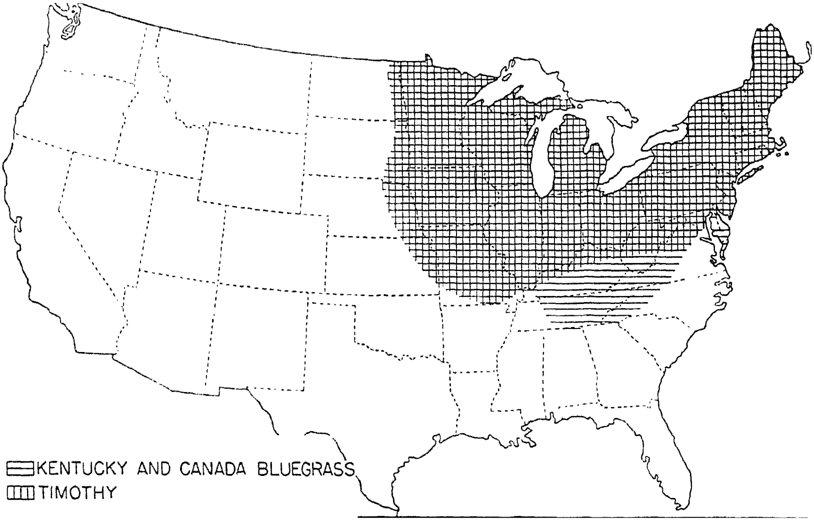

Figure 45. Sections of the United States where Kentucky and Canada bluegrass are well adapted and of primary importance.

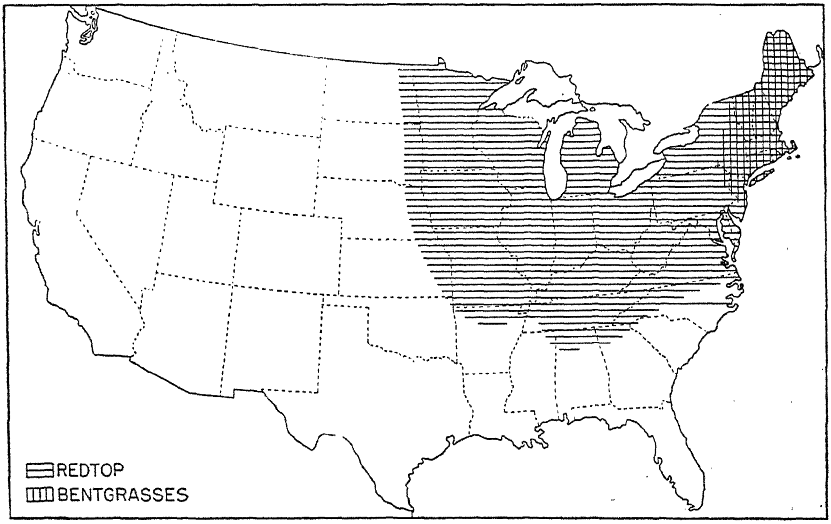

Figure 46. Sections of the United States where redtop and the bent grasses are well adapted and of primary importance.

The various agricultural experiment stations are engaged in programs designed to lead to improvement of the grass plants of local importance. The farmer will naturally learn from these stations what advancements have been made in quality and production, so that he may be able to make practical applications to his own decisions and activities.

KENTUCKY BLUEGRASS, CANADA BLUEGRASS, AND TIMOTHY

These three grasses may be considered together as they possess many characteristics in common. All persist under conditions of ample rainfall and are thus limited to the eastern areas, except for a region in the Pacific Northwest. The extensive area occupied by the three grasses is illustrated in the preceding Figure 45.

Kentucky bluegrass does not persist during hot dry periods. There is need for improvement in its ability to grow under the adverse conditions of midsummer. Finer leaf type making for more palatable and nutritious forage is desired.

Canada bluegrass is able to persist under drier conditions than Kentucky bluegrass but it is inferior in quality of forage. Also, it fails to yield the quantity of forage desired of a good pasture grass. Breeding programs should lead to improvement in these characteristics.

Timothy is very much the same as it was when first imported into this country. There is need for finer-leaved types which do not become so coarse. Further, while timothy is used for both hay and pasture, the plant leaves much to be desired as a pasture crop. A ranker growing, fine stemmed, quick recovering type is desired. Ability to persist under drier soil conditions would make timothy suited to a much wider area.

REDTOP AND THE BENT GRASSES

Redtop and the bent grasses occupy much the same area as Kentucky bluegrass and timothy.

Farmers recognize the suitability of redtop to low wet soils but then also appreciate the relatively poor quality of hay and pasture produced when compared with timothy or bluegrass. There is need for improved palatability and quality, if redtop is to be entirely acceptable to farmers who have need for either hay or pasture or for both.

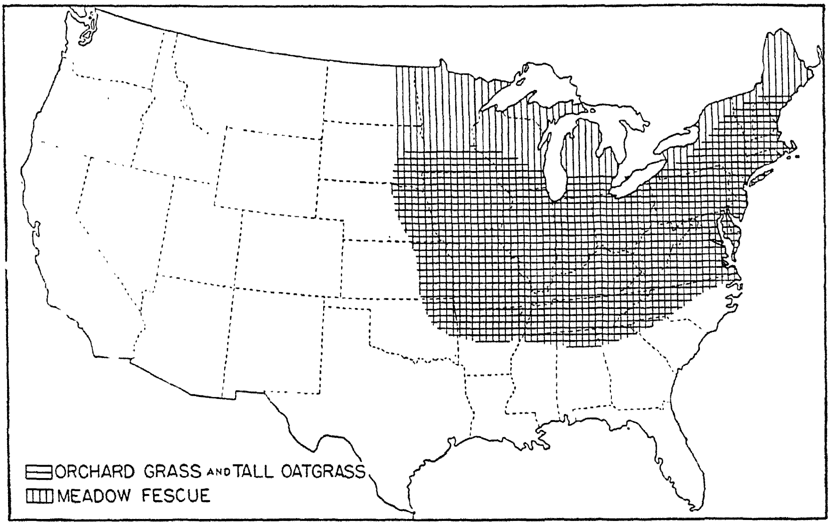

Figure 47. Sections of the United States where orchard grass and tall oat grass are well adapted and of primary importance.

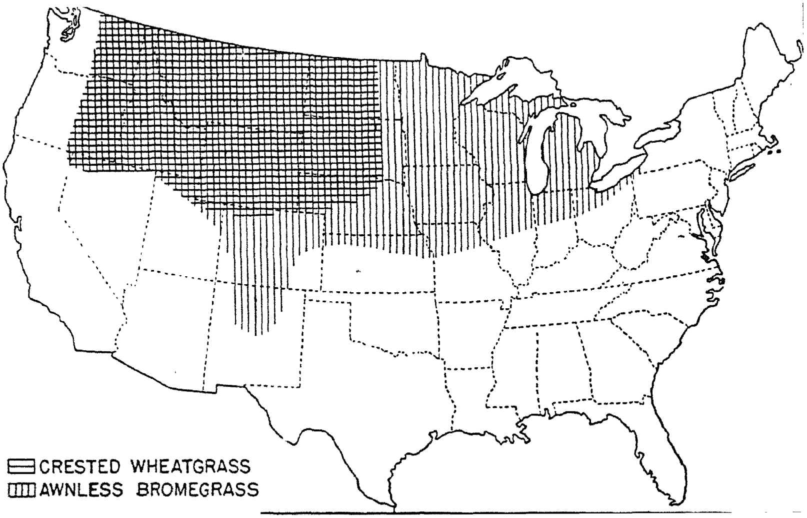

Figure 48. Sections of the United States where awnless brome grass and crested wheat grass are well adapted and of primary importance.

The bent grasses, as we have learned, are of greatest value on lawns and golf courses. Disease susceptibility is a limiting factor. Breeding should lead to resistant types. Some of the varieties of bent grass require more care than is possible for the average home owner. Improved types more tolerant of dry and infertile soils would be of immense value to the home owners as well as to the managers of golf courses.

ORCHARD GRASS AND TALL OAT GRASS

Neither of these grasses is widely known by farmers. Each possesses possibilities for both meadow and pasture. There is need for improved persistence of each under drier, more exposed soil conditions. Winter hardiness might be improved through breeding. Present types tend to be coarse and a breeding program should include improvement of these characteristics.

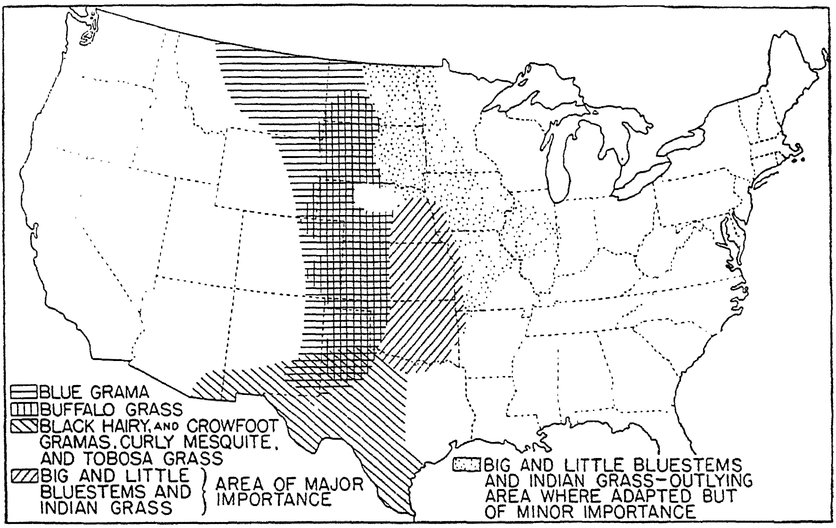
BLUE GRAMA
BUFFALO GRASS
BLACK HAIRY, AND CROWFOOT GRAMAS, CURLY MESQUITE, AND TOBOSA GRASS
BIG AND LITTLE BLUESTEMS AND INDIAN GRASS
AREA OF MAJOR IMPORTANCE
BIG AND LITTLE BLUESTEMS AND INDIAN GRASS–OUTLYING AREA WHERE ADAPTED BUT OF MINOR IMPORTANCE

Figure 49. Sections of the United States where native short grasses and prairie grasses are well adapted and of primary importance.

CRESTED WHEAT GRASS AND SMOOTH BROME GRASS

Crested wheat grass, when grown under more humid conditions than the dry areas where it is especially adapted, often proves susceptible to disease and fails to persist. Plant breeding offers the possibility of developing varieties adapted to regions of greater humidity.

Awnless brome grass is a persistent grass under a wide variety of conditions. The types available tend to become sod-bound, thus reducing production greatly. Breeding for higher-producing varieties of superior quality is a primary problem in the improvement of brome grass.

NATIVE SHORT GRASSES AND PRAIRIE GRASSES

For the most part our valuable native grasses are much the same as they were when the United States was first settled.

Simple selection by the isolation of superior types should bring quick results. Several of the grass-breeding stations are busily engaged in this work. A great need to aid in their distribution of these grasses is an improvement in the ability of the species to produce seed.

While many of them are very drouth-resistant, the types are badly mixed. Beyond a doubt, better quality of forage should result from a planned program of plant breeding and ability to persist in relatively pure stands.

SOUTHERN GRASSES

The prominent southern grasses Bermuda, such as Johnson, Dallis, Napier, Bahia, Para, and carpet grass, are all subject to improvement.

Both Bermuda and Johnson grass tend to become weeds because of their persistence. Less aggressive types would appear to be a desirable goal. Both these grasses tend to become rather coarse and unpalatable under certain conditions.

Carpet grass is valuable as a pasture crop in the far South.

Bahia and Para grasses are limited to semi-tropical conditions. Little has been done to improve the existing types.

Napier grass grows large and rank, producing a rather low quality of forage. Selection of existing types offers the possibility of a more desirable plant than is generally grown.

WESTERN AND SLENDER WHEAT GRASSES

Western wheat grass is naturally adapted to most of the Great Plains area and has proved very valuable as a producer of an abundance of forage. The principal weakness of the grass lies in its rather coarse stems and leaves. The plant breeder may expect to develop high quality forage types that will prove much more suitable for livestock feed.

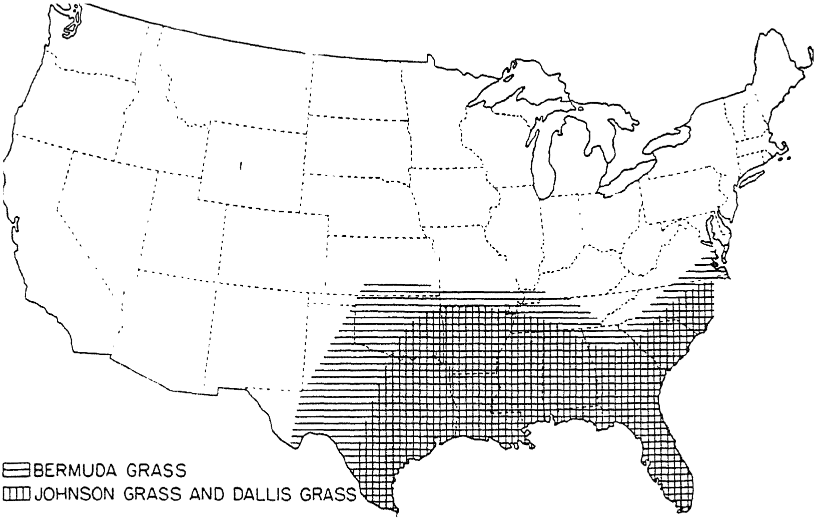

Figure 50. Sections of the United States where Bermuda, Johnson, and Dallis grasses are well adapted and of primary importance.

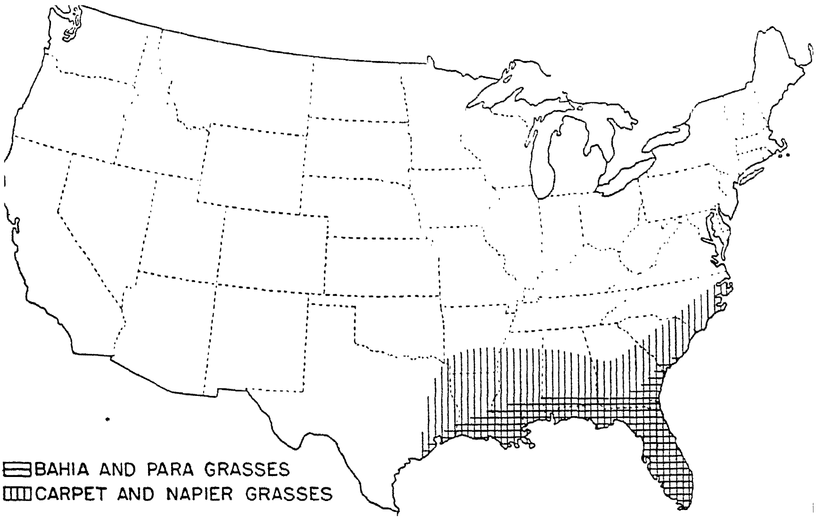

Figure 51. Sections of the United States where carpet, Napier, Bahi, and Para grasses are well adapted and of primary importance.

Slender wheat grass has many of the characteristics of the western wheat grass. As it is a bunch grass, it does not occupy as pure stands as western wheat grass. Although the slender wheat grass produces a finer and more leafy forage than western wheat grass, it can be improved in quality of plant and ability to succeed under a wider range of moisture conditions.

OTHER GRASSES

Sudan grass while an introduced annual is widely used as a hay and pasture crop. The plant is very drouth-resistant, but it is not tolerant of moist hot climates. Breeding to develop types resistant to humid warm areas is desirable. The forage tends to grow rather coarse and rank. Types which are free from the poisonous character which frequently causes trouble are much to be desired.

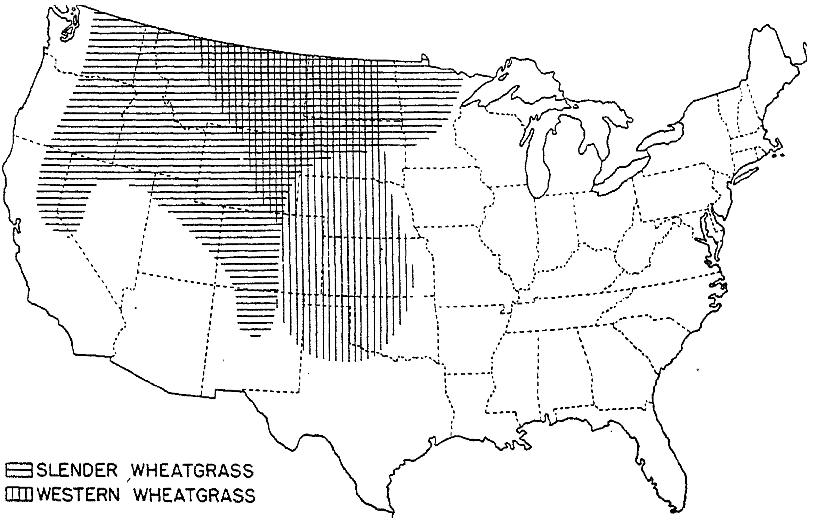

Figure 52. Sections of the United States where slender wheat grass and western wheat grass are well adapted and of primary importance.

Reed canary grass grows well under the adverse conditions of low, sometimes flooded soils. The principal criticism of the plant is that its leaves and stems are rather coarse. Careful work is needed to improve the forage quality. It should be possible to produce types better suited to the warmer sections of the country. Varieties of reed canary now available are definitely cool-climate sorts in their adaptation.

Many other grasses, both native and introduced, may be improved through breeding, if the plant breeder can find the time to work with them. With greater attention paid to forage breeding, we may expect grasses to be improved much the same way as corn and the small grains have been.

OBJECTIVES IN BREEDING GRASSES

Vinall and Hein, of the Bureau of Plant Industry, United States Department of Agriculture, have suggested the following opportunities for the improvement of forage and lawn grasses:

1. Yield and viability of seed.
2. Disease resistance.
3. Ability to compete successfully with other plants.
4. Increased vigor and ability to recover quickly after harvest.
5. Long life, resistance to drouth and cold.
6. Tolerance to wet or saline soils.
7. Improved palatability and nutritive value of herbage.
8. Uniformity, persistence, and quality of turf grasses.

A discussion of each of these major objectives will make clear the significance of each in an important program.

Increasing Yield and Viability of Seed. Nature has been permitted to perpetuate the common grass species as she saw fit. They have not been improved for seed production as the grain crops have been. Sufficient seed was produced to carry on the species and in many cases but little more seed developed. It is strange that many of our best grasses produce the least seed. Naturally, a plant that produces an abundance of forage is more likely to produce insufficient seed as the energy required to produce one tends to reduce the energy available to the other. This condition, of course, is not necessarily unchangeable. Sudan grass and timothy are examples of heavy forage producers that also yield an abundance of seed under favorable conditions.

With many of the grasses, the seed produced is likely to possess low germinability. This tendency has been true of the gramas, buffalo grass, the bluestems, the wheat grasses, and several other native species important in our country. Many of the introduced species have the same defect. Even when an abundance of seed is produced, it may possess such low viability that it is difficult to secure a good stand when the grass is seeded in a new area. As a result of the low yield of seed and its relatively low germination, it has sometimes been impossible to secure sufficient viable seed for our needs. Research workers have done much to improve methods of harvesting, so that greater production is possible. Considerable work must be done to insure a better germination of the seed produced, if we are to distribute the improved species rapidly.

Disease Resistance Essential. Few growers have appreciated the importance of the multitude of diseases which attack grass crops. Because the crops are grown on extensive areas and it is difficult to measure reduced yields, many fail to note the damage from diseases and its significance.

Many rusts and mildews attack the grass plants. Seedling diseases are responsible for the destruction of young plants before they can become established. Ergot attacks many grasses and may cause epidemics. For example, ergot is the chief limiting factor in the production of Dallis grass. Crested wheat grass, which appeared very promising in the Middle West, is susceptible to disease when it is grown under more humid conditions. Unless resistant strains are developed, its production is certain to be restricted. Sudan grass in the humid sections of the South is practically eliminated by leaf diseases. Numerous lawn-grass diseases are a real problem. The susceptibility of the bent grasses to such diseases as brown patch causes much difficulty on both golf courses and lawns. On such intensive areas as golf courses and lawns, fungicides may be used successfully. Disease-resistant varieties, however, would be highly desirable. On extensive areas, as in pastures, it is impractical to use fungicides. Resistant varieties appear to be the only practical solution. Beyond a doubt careful investigations will disclose that diseases do more damage to pastures and meadows than is generally believed. There is every reason to believe that successful control may be effected with the pasture and meadow crops, as has been so ably demonstrated with the cereal-crop diseases.

Ability to Compete. This is a difficult problem, as some plants possess too great ability to compete with other plants and, as a result, become weeds. For this reason some farmers look upon brome grass as a weed. Johnson grass and quack grass are valuable until the grower decides to get rid of them and then he finds them very persistent. As considered here, we are concerned with the improvement of the aggressiveness of the desirable grasses. In permanent pastures it is especially important that the desired grasses be able to compete with the undesirable weed plants which tend to gain control. The unpalatable weed plants are rejected by livestock and thus they have an added advantage in competition. As the desired grass is reduced in percentage, it is likely to be subjected to even more intensive grazing and more rapid destruction and infiltration of the undesirable species which usually are weeds.

One of the important problems of the breeder is to develop types of grasses and legumes that may succeed in mixtures and thus provide growth throughout a longer season and furnish a better balance of feedstuffs from a nutritional viewpoint. The breeder must avoid the coarse, rank-growing persistent species of low quality. This is usually the type that is most persistent. Accordingly, he must choose a type that possesses quality for feed and yet is sufficiently persistent to maintain itself under the rigorous conditions of grazing.

Increased Vigor. The vigor of a species may be the determining factor in its suitability. A good hay plant is one that, after a crop has been harvested, has the ability to develop one or more additional crops within the season. The same quality is needed in the plants that are to be grazed. If one pasturing in the early summer results in total depletion for the season, then the grass is of less value than a grass which may be grazed several times during a season. The habit of Kentucky bluegrass in becoming dormant during the middle of the summer is disadvantageous. It means that the stockman must provide supplementary pastures during those months. Breeding offers some possibility of developing a bluegrass which will stay green throughout the summer. If bluegrass possessed the ability of Sudan grass to grow throughout the summer, it would be worth millions to the farmers of the Nation.

The student must bear in mind that the plant must build up a storage of energy if it is to persist under long periods of grazing. The plant without underground storage organs, such as are possessed by timothy, must have a longer period of recovery between harvests, as measured by periods of intensive grazing. Much can be done to improve our species in their ability to persist after removal of their foliage either as hay or as pasturage in a planned program of improvement.

Long Life, or Persistence. It is difficult to separate one of the factors listed above from another, as they tend to be closely interrelated, with considerable interdependence.

The ability of a grass to persist under semi-arid conditions is absolutely necessary in many of our grazing regions. For this reason it may be necessary to sacrifice a certain degree of quality to secure a species which will grow. Beyond a doubt the species that will persist may be improved in quality.

Resistance to cold winter temperatures is essential in many areas and may be associated with drouth resistance. The plains area, where the winds have a full sweep, may be bare during the cold season and thus be subjected to very low temperatures. The effect of the moving winds is to remove all available moisture, so that the plant lacking in drouth resistance has little chance of succeeding.

The factors responsible for drouth resistance and winter hardiness are not simple. Careful study of the material found in a region may lead to valuable information which may prove basic to further breeding work. With the vast areas of our country suited only to the production of forage for grazing this problem is one that should not be delayed.

While we have vast areas of soils that are too dry, conversely large acreages are too wet for the best growth of many plants. Fortunately, some of our grasses will succeed on low wet soils. Many of these plants are rather coarse, unpalatable species that are of little value, but some of them show great variability, and it does not appear too much to expect that improved types of water-tolerant grasses may be developed.

Many of our soils are high in alkalinity. There is need for finding palatable grasses capable of growing on such soils. The development of a satisfactory type would result in the reclamation of millions of areas of worthless land.

Improved Quality. This phase of improvement is largely untouched. Much can be done to improve the quality of our present grass crops. The development of a finer type of timothy is an example. The new timothy, with its finer leaves, is more palatable and the nutritional advantages over the coarser-growing types are great.

The smooth brome grasses are rather rank-growing coarse plants. Breeding should result in superior types. It has been demonstrated that superior types of Reed Canary grass may be obtained by selection. The end is not in sight, and we may expect further improvement when the grass breeder co-operates with the nutrition specialist to test his new productions to determine their feeding qualities. There seems to be equal reason for expecting differences in the quality of a forage plant, as in a wheat plant. In the wheat varieties great differences have been demonstrated. It does not seem to be unreasonable to expect similar results with the grasses when breeding work has reached the same stage of development that it has with wheat.

The Turf Grasses. Much progress has been made in the development of improved grasses for lawns and golf courses. Some of the bent grasses form a nearly ideal surface for putting greens. Disease susceptibility, however, still constitutes a real problem and costs golf clubs large sums of money every year. Progress should be made in developing types which are better competitors of weedy plants that encroach upon the greens. The average home owner desires a lawn grass which will grow throughout the summer season, one that can successfully compete with undesirable plants with a minimum of care. Whether the perfect grass can be found is doubtful, but certainly there is reason to believe that much progress can be made.

TECHNIQUE OF BREEDING GRASSES

To understand the methods of improving grasses it is necessary that one be familiar with their botanical characteristics. Previously, we have considered the grass flower in the discussion of wheat improvement. Since wheat, oats, barley, and corn are members of the Grass Family, the flower structure of the grasses used for forage is very much the same. In many cases, the flowers are much smaller, so that their characteristics are not as evident upon casual observation.

The flower structures of grasses range from a compact spike-like panicle, as in timothy or crested wheat grass, to the more or less loose panicle found in bluegrass and redtop. All grasses begin their blooming period near the tip of the panicle and progress toward the base. Within the individual spikelets, blooming starts near the base and progresses toward the tip. This information is of value to the breeder, when he is emasculating flower parts.

Grasses bloom most frequently during the early morning. They will, therefore, shed their pollen in the early hours. Sando, a leading worker with grasses, reports that blooming is most active when the sun is shining and the temperature is 70° F. or above. He was unable to observe flowering at temperatures below 52° F.

In many respects the methods of crossing the grasses are similar to those given for wheat and other grain crops. The smaller size of the flowers makes it more difficult to make satisfactory crosses than in such a plant as wheat.

With species that are not male sterile (species whose male flower parts fail to produce fertilization within its own flowers), it is necessary to emasculate the male parts in much the same way described for wheat. This work is done just before blooming. While one may depend upon the naked eye, most breeders use a lens to magnify the flower parts. A type of binoculars which fastens upon the head much like spectacles is preferred by some. Others use a higher-powered binocular miscroscope attached to a swinging arm. Either of these methods permits free use of both hands in delicate emasculation operations.

Sando, of the United States Department of Agriculture, has developed a very satisfactory technique for grasses. His methods involve the following steps: The upper and lower spikelets of the inflorescence are cut away with fine scissors prior to their flowering. Of the spikelets left, all but the two lower florets are removed. Next, the anthers are carefully removed from the florets left. A very slender pair of tweezers is necessary to avoid damage to the floret. Following removal of the anthers, the panicle is enclosed in a glassine bag, tied to a stake, and properly labeled. A few days later, when the stigmas are ready for pollination, mature pollen from the male parent is collected, the glassine bag is removed, the pollen is dusted on the stigmas, and the bag is replaced until maturity.

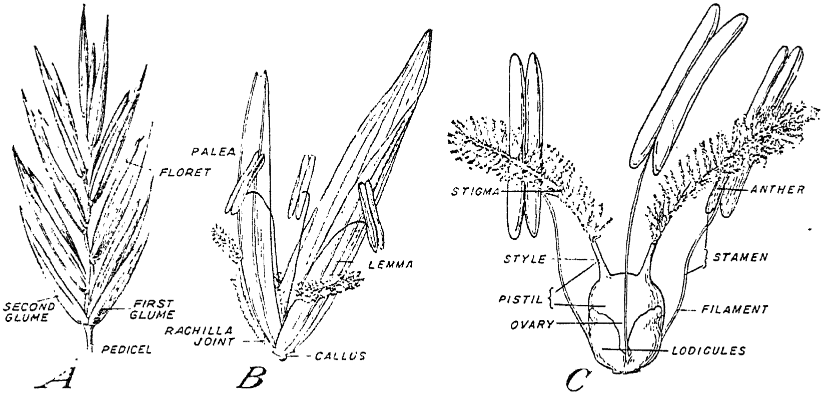

Figure 53. A typical grass inflorescence. A, spikelet indicating the alternate arrangement of florets on the rachis and relative positions of the glumes; B, grass floret opened as at blooming time, showing how the lemma and palea are forced open by the lodicules; C, typical grass flower showing the essential organs necessary in fertilization.

Sando uses a sheet of clean paper to collect the pollen, holding it beneath the blooming flowers, and shaking them to cause the pollen to fall on the paper. He prefers the use of tweezers to apply the pollen to the female flowers. Other workers have used a soft brush to advantage. Some workers collect the pollen in a glassine bag much as is done with corn.

The time elapsing after emasculating before pollination varies with the species. Most species remain receptive for several days. The usual practice is to pollinate 48 to 72 hours after emasculation. If several flowers are pollinated, it is probable that fertilization will occur in several cases.

Many breeders find it advisable to make crosses in a greenhouse where external conditions are under control. Usually the results are more satisfactory under these conditions. Difficulty has been experienced by some workers when paper bags are used in the field. A closely-woven cotton bag may be more satisfactory, as it is less likely to result in unfavorable conditions of heat and humidity within the bag. Oftentimes unfavorable periods of hot weather at the time of crossing may result in a low percentage of successful crosses.

IMPROVEMENT OF TIMOTHY

More work in this country has been done in the improvement of timothy than with any of our other grasses. Timothy is one of our most important forage crops. Although the acreage has decreased within recent years, it is still grown on millions of acres either alone or in combination with other grasses and clovers. The ability of the timothy plant to grow on soils unsuited to the production of alfalfa or clover has led to its retention in spite of its lower feeding value as compared with legume hays. It is very palatable as a pasture grass, and many farmers use it for both hay and pasture.

One of the earliest breeders of timothy was Willet M. Hays, of the Minnesota Agricultural Experiment Station, who made a number of selections in 1889. The early work of Hays was followed by that of other investigators in several of the state experiment stations and the United States Department of Agriculture. The Cornell and the Iowa Stations did considerable work in selecting improved types. The United States Department of Agriculture has carried on work for several years, and the varieties Huron and Marietta were developed in co-operation with the Ohio Agricultural Experiment Station.

OBJECTIVES IN TIMOTHY BREEDING

Timothy, being a cross-pollinated plant, is a mixture of many types. It is fairly easy to select widely differing ones. Breeders seek to imbue the earlier strains with greater disease resistance. A finer, more leafy type of growth is desirable under most conditions. Also, those who use timothy for pasture desire a type with finer leaves and greater ability to recover following intensive grazing.

Some progress has been made in the developing of leafy pasture types of timothy. The New York Agricultural Experiment Station has secured excellent results with Aberystwyth Pasture Timothy S. 50, a variety imported from the English Station where it was developed as a pasture type. Several of the state experiment stations are testing this variety and similar types.

The pasture timothy varieties produced in Europe do not produce seed well except in the northern latitudes. It is desirable, therefore, to improve their seed-producing abilities.

The pasture timothy varieties are characterized by short stems which grow more closely to the ground than the common upright varieties and do not produce flowering heads so frequently. Thus it remains in a vegetative stage for a longer period of time. These types are not perfect and should be improved in ability to resist diseases, particularly rust. They need to be more winter-hardy and drouth-resistant.

METHODS OF IMPROVING TIMOTHY

As stated before, timothy is normally cross-pollinated. This crossing has produced a great variety of types and selection offers great possibilities, but the tendency for cross-pollination makes it difficult to maintain variety, once it has been produced.

Two general methods of selection may be followed. One is to select the promising plants, harvest the seed, and plant it in a small plot. Notes are recorded on the characteristics of the plants, their rate of growth, earliness, time of flowering, fineness of leaf, disease resistance, and other agronomic characters. Plants selected are transplanted to cultivated rows where each plant is grown alone. Continued selections are made for the desired type. As soon as a uniform promising strain is isolated, it is increased, named, and distributed as an improved variety.

Other workers follow the plan of isolating the strains by bagging the timothy heads to force self-pollination. As with other normally cross-pollinated crops, vigor is reduced greatly. After the lines are purified, they may be combined by hybridization and an improved variety may result.

IMPROVED VARIETIES OF TIMOTHY

Although relatively few stations have engaged in grass breeding, some progress has been made within the past few years. Several states are now engaged in active work and use is made of improved types developed by other countries. Some of the more important varieties of timothy are Shelby, Marietta, Huron, and the Welsh pasture type.

The Shelby variety of timothy is the result of selection by William Zoebel, of Shelbyville, Indiana. Mr. Zoebel and his sons selected for earliness for many years. Seed was gathered from the haymow floor. His method tended to select the earlier maturing types. Most of the farmers in the region of Shelbyville grow the variety and consequently little seed is exported from the region.

Huron is a late-maturing variety originating from a plant found growing on a roadside in north-central Ohio. The plant was removed to the timothy breeding station at North Ridgeville, Ohio. From here seed was distributed to several of the state experiment stations. The variety has done especially well in the Pacific Northwest where its ability to grow for a longer season makes it especially suitable for pasture mixtures. Huron is grown extensively in the Pacific Northwest.

Marietta, also developed at the North Ridgeville, Ohio, Station, resulted from selection. The variety is earlier than ordinary timothy and yields have been higher, especially in the latitude of southern Ohio. The earlier maturity of Marietta makes it more suitable for growing with medium red clover or alfalfa, as the combination crops mature at more nearly the same time.

The Welsh pasture type of timothy was developed for pasturage. The lower-growing, short-stemmed plants appear most promising, but further tests are needed before its rightful place in American agriculture can be finally determined.

IMPROVEMENT OF OTHER GRASSES

As indicated before, comparatively little has been done to improve grasses by breeding. Timothy has received more consideration than any of the other grasses. Many of the other grasses present problems similar to those of timothy. Most of the grasses are naturally cross-pollinated. As a rule, the annual grasses are highly self-fertile, but the perennials tend to be highly self-sterile. These facts greatly complicate the problems of the plant breeder.

As contrasted with the cereals, relatively little is known concerning the breeding behavior of the grasses. The modern plant breeder is not satisfied to depend upon visible plant characters alone. He uses his microscope to study the bearers of the hereditary characteristics, the chromosomes. By determining the chromosome numbers he is better able to plan his breeding program. The modern cytogeneticist plans his breeding program much as an engineer prepares his blueprints for a new building. This carefully-planned approach should lead to greater progress in grass improvement, as it does away with many of the hit-or-miss methods so prevalent in the past.

One of the finest opportunities to improve the grasses is to make a careful check of existing types. Within a given area there are many diverse types as is evident when one examines the grasses in a pasture or meadow. Some plants are early, some are late. Some plants have fine leaves; others are coarse. Some are dark green; others are light green. By gathering plants which appear promising the breeder may start a nursery at little cost and from this initial selection start an improvement program. This type of practice is being followed by some of the experiment stations. In short, the investigator seeks to determine that which already exists. If he can locate an improved type by this method he makes rapid progress in his program.

In America we have been able to take advantage of the work of stations in other parts of the World. Not a few of our improved grass strains have come to us in this way. The free exchange of materials between scientists is a splendid thing for world progress in plant improvement.

Breeders have utilized selection whenever possible. As with the grain crops, this is often the first method of improvement. Ultimately, the breeder resorts to hybridization as he sets out to produce superior types of plants. With the aid of a knowledge of the inheritance of the species it is possible to plan hybrids between species and thus increase the possibilities of plant breeding. In a few cases, genera have been combined in the same manner. The crossing of the *Triticum* and *Agropyron* genera has given promising results. Likewise, workers at the Welsh Station have crossed the genera *Festuca* and *Lolium*.

Many years may be required to secure the ultimate benefit of such crosses, but it seems likely that such matings are certain to lead to types of plants never known before, and reasonable to suppose that some may prove decidedly superior.

IMPROVED GRASS STRAINS

To illustrate the trend of grass improvement and some of the major accomplishments, let us consider what has been done to improve varieties. As indicated, most of the variety improvement has resulted from selection. A few of the more important varieties resulting from selection are given below. The student is cautioned, however, to remember that, for the most part, the improved strains are not widely grown and represent indications of possibilities rather than accomplishments as significant as the development of a wheat variety such as Thatcher.

Bent Grasses. Two strains of creeping bent grass developed by the United States Golf Association are the Washington and Metropolitan bent grasses. These strains are widely grown throughout the country.

Velvet bent grass, strain F. C. 14276, has shown superiority over the ordinary velvet bent grass, possessing greater vigor, disease resistance, and quality of turf.

The improvement of strains of *Poa pratensis* and *Poa trivialis* gives considerable promise.

Reed Canary Grass. Iowa Phalaris (Iowa 503), a promising variety selected by workers at the Iowa Agricultural Experiment Station, produces high yields of hay and seed and has proved valuable as a pasture, since it forms a dense turf and remains green late in the fall.

Highland Reed Canary grass is a heavy seed producer and is better suited to upland soils than the Reed Canary grass.

Tall Fescue. Strain F. C. 29366 is a product of the United States Department of Agriculture and the Oregon Agricultural Experiment Station. It is tall-growing and has softer, finer leaves, making it a better forage type than ordinary fescues.

Tall Oat Grass. Strain F. C. 29378 is a variety that retains its seed much better than the ordinary oat grass.

Slender Wheat Grass. Grazier, a variety developed in Canada, is a leafy strain that yields a large quantity of hay and pasturage. Tyra is another Canadian strain that gives a higher yield of superior hay than ordinary slender wheat grass.

Crested Wheat Grass. Fairway crested wheat grass, another Canadian development, is a short, fine-stemmed, leafy strain that produces a dense turf suitable for golf fairways and lawns.

Brome Grass. Superior, a Canadian variety, gives a higher yield of both hay and pasture than the ordinary brome strains.

Parkland brome grass does not develop such strong creeping rhizomes characteristic of brome grass and, as a result, is essentially a noncreeping type. For this reason the variety does not tend to become sodbound so quickly as most brome grass and is easier to eradicate, when grown in rotation with cultivated crops.

Orchard Grass. Avon is an improved variety which has proved more winter hardy, thus making it longer-lived than commercial orchard grass. The variety also yields more hay and provides an abundance of pasturage.

Bermuda Grass. This southern grass has been improved by selection. Tift is a vigorous, fine-stemmed strain developed for the South and has proved more productive as a hay plant than the common Bermuda grass strains. It has been propagated vegetatively, since Bermuda grass fails to produce any quantity of viable seed in Georgia where it was produced.

THE FUTURE OF GRASS IMPROVEMENT

The preceding examples of improved varieties of grasses serve to illustrate what has been done with relatively little intensive breeding. Even today many state agricultural experiment stations do not have intensive grass-breeding projects. With the passing of time it becomes more and more evident that America must pass from her extensive agriculture to a more intensive type. The significance of grasses in a program of permanent agriculture becomes more and more evident and the time is here when the plant breeder must give the same careful attention to grass breeding that has been taken as a matter of fact in the improvement of the grain crops for many years.

Many studies may be made within a relatively short time, as we take stock of our present grass resources, and it is necessary to grow large nurseries where native and imported species may be studied and classified. From these nurseries may come greatly-improved strains as a result of simple selection.

Following the improvements by selection, grass breeding may be expected to follow the plan used with the grains. The controlled mating of superior sorts should result in improved types and possibly new species as the plant breeder utilizes the tools of his trade. The work of the cytologist and the geneticist in analyzing the hereditary make-up of the species may lead to improved strains that are built along predetermined lines. By applying the scientific method to grass breeding who can predict how far progress may take us in the future?

With improved types of grasses, it may be possible for community action in the utilization of strains. Since most of the grasses cross readily, an entire community growing a strain should be able to maintain it relatively pure and free from mixture. Every student of agriculture should be interested in these possibilities in the various relationships to an improved agriculture.

Suggestive Questions

1. How many stamens are found in the grass flower?
2. What are the native grasses found in your community?
3. What grass-breeding stations are nearest to your school?
4. How could a community work together to best utilize an improved strain of a grass species?
5. What grasses are found in the permanent or temporary pastures on your farm?
6. What improvements do you believe would be of value in the grasses found on your farm?
7. What grasses are used in the lawns in your community?
8. Why does bluegrass stop growth during the middle of the summer?
9. What foreign countries have led in grass-breeding work?

Suggestive Activities

1. Examine the maps showing the location of the different grass species. Enumerate characteristics which lead to the adaptation of each species.
2. In the field, emasculate grass flowers, cross with pollen from a male parent, place a bag on the plant, label, and harvest when mature. Write a story of the steps followed.
3. Make a collection of native grasses. Label each as to its uses and adaptation.
4. Visit low, wet areas and dry, sandy sections, if possible. Record the types of grasses found in each place.
5. Examine the root systems of grasses found in dry spots and contrast with those of grasses in more moist soil. Explain.
6. Make a collection of seeds of the important grass species. Learn to recognize each alone or in mixtures.

CHAPTER XI

THE IMPROVEMENT OF LEGUMES

The Legume Family of plants is second in importance only to the grasses on most farms of the Nation. Few farmers could conduct their farm operations on the basis of permanent agriculture without the growing of legumes. As we have learned, the legume, because of its ability to take nitrogen from the atmosphere, manufactures the valuable protein essential in the feeding of livestock. Not only is protein of value to livestock, but, also, many foodstuffs from legumes are important parts of the human diet. Examples are peas, beans, and peanuts. Alfalfa, too, is being prepared for human food.

Nearly every farmer is familiar with improved varieties of grain crops. The grain plants have been studied more intensively and greater advances have been made in their improvement than is true of the legumes. To a considerable extent the legume varieties are much the same as they were many years ago. At present, research workers are turning their attention to the breeding of legumes, and it is to be expected that great advances may be made within the near future.

TYPES OF LEGUMES

The legumes constitute widely diverse types of plants. As to length of life, there are annual, biennial, and perennial species. Common annuals are beans, peas, soybeans, and peanuts. Examples of biennials are medium red clover, alsike clover, and biennial sweet clover. Alfalfa is the best known of the perennial types of legumes, with the United States growing between 10 and 15 million acres each year. Because of the great differences between various legume varieties it appears most logical to consider the improvement problems of important individual types and groups of types. Alfalfa and soybeans are very different and are of such importance that each will be discussed individually. The clovers, on the other hand, may be grouped, as several have similar characteristics and the improvement problems are not greatly different.

ALFALFA

Alfalfa, the most important of the legume hay crops, is widely grown. As we have learned, it is best adapted to regions of relatively low humidity and where soils are rich in calcium. Man, through his improvement efforts, has been able to extend the growth of alfalfa widely through breeding and proper soil management. In areas where it is not adapted, other legumes, as the lespedezas, the soybean, and the cowpea assume greater importance.

Botany. Alfalfa is a representative of the great family *Leguminosae*. It is a member of the genus *Medicago*. Several species of Medicago are known, but most of our alfalfa varieties are *M. sativa*. The ordinary common alfalfa is characterized by blue or purple flowers while the more hardy varieties usually show a mixture of flower colors ranging from white, cream, yellow, bluish-green, and smoky-green to purple.

The alfalfa flower is rather typical of legume flowers in general. The corolla consists of four parts: the large expanded portion at the back is the standard; the side petals are referred to as wings; and the boat-shaped part beneath the wings is the keel. The flower contains an elongated pistil which, following fertilization, develops into the pod which bears the seeds. In alfalfa there are 10 stamens arranged about the pistil in such a manner that the pollen can not reach the pistil unless the flower is "tripped." Tripping releases the stamens, so that they bring their pollen in contact with the pistil. Tripping usually follows the visits of insects, such as the bee. Insects, passing from flower to flower, transfer pollen and cause cross-pollination according to the rule in alfalfa seed production.

Improvement. Alfalfa was brought to the Americas by the early Spanish explorers. The crop was soon distributed over Peru and Chile and probably was taken to southwestern United States by Catholic missionaries. It is certain that the plant was grown in the Southwest early in the history of the United States. Early colonists brought alfalfa to the colonies under the name of lucerne. While some farmers were successful with the new crop, most fields of alfalfa failed on the low-lime soils of the seaboard. As nothing was known about inoculation of the soil, this lack doubtless contributed to the failures.

Alfalfa has succeeded remarkably well in the West, so that most of the spread of the crop has been from west to east. The Mormons are credited with having introduced alfalfa growing into Utah, having secured seed in California. From here the culture spread to Colorado, Kansas, and Nebraska. By the beginning of the twentieth century, alfalfa was being grown on the well-drained, fertile soils of Iowa and Missouri. Joe Wing, an early crusader for alfalfa, successfully grew the crop in Ohio.

The year 1857 is important in the agricultural history of America, for it was in that year that Wendelin Grimm moved from Germany to Carver County, Minnesota. Grimm, like many other emigrants, brought with him seed supplies from his old home. In the spring of 1858 he planted some 15 to 20 pounds of alfalfa brought from Germany. This planting proved successful and marked the first time anyone had been able to grow alfalfa so far north. From this modest start came the alfalfa so widely grown today under the name of its founder, Grimm. It was many years after Mr. Grimm grew alfalfa in Carver County before the variety was publicized and distributed.

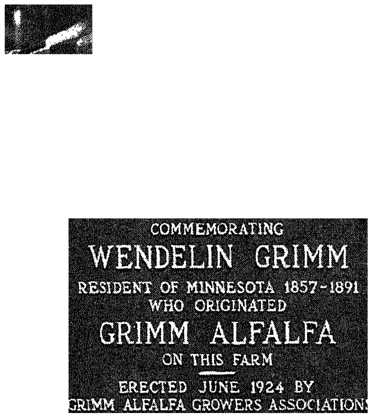

Figure 54. Monument erected in honor of Wendelin Grimm, who was responsible for the hardy variety of alfalfa bearing his name.

Much credit must be given to Mr. Grimm as he developed the variety by constantly harvesting seed from the plants that survived the Minnesota winters and thus, aided by Nature, he produced a hardy variety which was to be grown very widely as the outstanding alfalfa variety for those states where winters are severe. Only recently has progress been made in the development of varieties superior to the Grimm variety, the principal weakness of which is its susceptibility to alfalfa wilt, a disease demanding increasing attention.

Early investigators followed the practice of mass selection in their efforts to improve alfalfa. A few of the earlier investigators attempted hybridization with poor results. These early breeders were concerned with the development of varieties possessing greater cold resistance or winter hardiness, higher yield of hay, greater resistance to drouth, finer quality of forage, resistance to leaf spot, the principal known alfalfa disease, and a great yield of seed for the perpetuation of the crop.

In many sections it was noted that alfalfa failed to produce seed in certain seasons. The reasons were unknown. Alfalfa seed is now produced in areas where it was believed impossible not many years ago. Diseases of alfalfa had not been studied and, due to the newness of the crop in most sections, probably were not of great importance on the average farm.

It is likely that more attention was given to winter hardiness by early breeders than to any other character. Seed was introduced from the sections of Europe and Asia where it appeared that winter hardiness would probably be a factor. Early introductions included the Baltic, Cossack, and so-called variegated varieties. One of the most successful varieties produced was Ladak, a selection by the United States Department of Agriculture from a nursery grown at Redfield, South Dakota. The seed from which Ladak was selected was introduced from northern India.

Shortly after alfalfa was successfully introduced into the midwestern states and Grimm was hailed as the most satisfactory of all hardy varieties, there came more and more reports of the killing of stands a few years after their establishment. Where it had been simple to maintain good stands of alfalfa for several years, fields often became unproductive within a comparatively short time. In 1925, the cause for stand reduction was found to be due to a disease which caused the alfalfa plant to wilt and die. This disease, discovered by Jones and McCulloch, was named alfalfa wilt (*Phytomonas insidiosa*), a bacterial disease which lives over in the soil once it has gained a foothold. The disease has spread rapidly until it is now distributed throughout the alfalfa-growing sections of the United States. The commonly-grown varieties, such as Grimm, Hardigan, and Common, are very susceptible to the wilt, and in many cases it is impossible to maintain a satisfactory crop.

It was believed, at first, that the bacterial wilt of alfalfa might be controlled through cultural practices, but these proved unsuccessful. The only possibilities appeared to be through breeding. The United States Department of Agriculture searched throughout the world to secure strains resistant to alfalfa wilt. A few strains from the region of Russian Turkestan, northern India, western China, and northeastern Persia offered promise. These are being used in an intensive breeding program in which it is planned to combine the desirable qualities of such varieties as Grimm and Common with the bacterial wilt resistance of the Turkestan types.

Technique of Breeding. Several workers have studied the pollination of alfalfa. It is known that considerable cross-pollination occurs in the field. Insects no doubt play a considerable part in the furthering of cross-pollination. In general, it appears that self-fertilization tends to reduce the vigor of the alfalfa plant, while cross-fertilization tends to result in hybrid vigor. It is generally believed that the alfalfas with variegated flower color, such as Grimm, are the result of crosses between *Medicago sativa* and, as a rule, *M. falcata*.

Several of the state agricultural experiment stations have produced superior strains of alfalfa. At the Nebraska station considerable progress has been made in breeding for cold and bacterial wilt resistance. It appears that each character is independent of the other. The present strains offer great possibilities for further breeding to produce superior strains resistant to both cold and diseases.

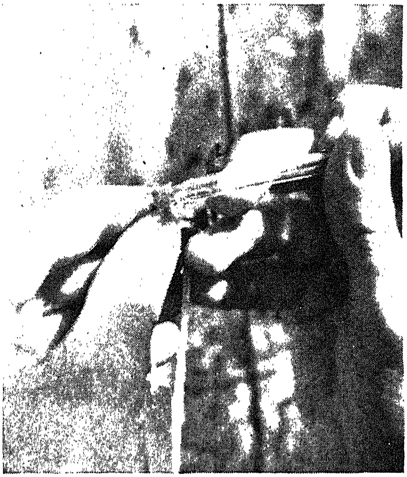

Figure 55. Emasculating alfalfa flowers by suction. The glass tube is placed between the flower parts and the suction removes the anthers and pollen. Suction may be obtained by a rubber tube attached to the intake manifold of an automobile or a tire pump may be employed.

The technique of crossing is somewhat similar to that employed with corn. The first step is to secure promising breeding material. Having chosen the breeding lines, the flowers must be emasculated as was discussed earlier with wheat, oats, and barley. Many workers use the suction method for emasculating the flowers. A small stream of water following the suction will serve to remove any pollen that may have remained within the flower. The method is illustrated on page 244.

Emasculation is done at the full-bloom stage. Care must be taken to remove all pollen. The pollen from the male parent is applied with a small brush about 24 hours after emasculation, and the pollinated flowers are then covered with a properly-labeled bag.

When it is desired to self the plants, they are placed in screened cages, in greenhouses, or a portion of the flowers is placed in a fine-mesh bag.

Objectives in Breeding. As has been indicated, two of the greatest problems in alfalfa improvement are to obtain greater winter hardiness and resistance to bacterial wilt. To these objectives may be added several others of more or less importance. A summary of the primary objectives follows.

1. Disease resistance.
2. Winter hardiness.
3. Increased seed-setting capacity.
4. Higher yields of good-quality forage.
5. Insect resistance.
6. Alfalfa more suitable for grazing.

Although alfalfa is a perennial, stands do not persist for more than 4 to 7 years under many conditions. Where alfalfa is grown in a rotation it may be desirable to plow the field before the stand is reduced. Much seed is, therefore, required. In most humid areas, seed setting is limited and the problems of securing sufficient seed are great. Even in areas where seed production is normal failure is not uncommon. Workers have studied seed-setting problems for years without determining the causes of poor setting of seed under certain conditions. Recent evidence has shown that an insect, the alfalfa plant bug, may be responsible for low-seed setting. Without doubt, improved seed setting of alfalfa is one of the primary objectives of the plant breeder.

High yields of high-quality forage are to be desired. While Ladak possesses bacterial wilt resistance, it does not recover after cutting as rapidly as Grimm. Decided improvement is desirable in present strains of alfalfa.

Insect resistance has been given little study. Most strains have not been subjected to a critical study. It is believed that the possibilities warrant complete investigation.

Alfalfa is grown primarily for hay. Frequently a farmer has need for supplementary pasture. There is need for types better suited to use for grazing. The dangers of bloat preclude the more extensive use of alfalfa pasture in many sections. It may be possible to develop strains which are less likely to cause bloat when grazed. This problem and many others should be considered in our future programs devoted to alfalfa breeding.

THE CLOVERS

Although the name clover has been applied to many plants, it is restricted, as a rule, to those plants belonging to the genera *Trifolium* and *Melilotus*. There are many species of clover, but our discussion here will be confined to the most important clovers: red (*T. pratense*), white (*T. repens*), alsike (*T. hybridum*), crimson (*T. incarnatum*), and the most important species of sweet clover (*Melilotus* spp.).

RED CLOVER

Red clover is the most important of the true clovers, being grown very extensively in the United States. The ability of the plant to grow under conditions where alfalfa fails has resulted in its continuing to be a very important forage crop in many of the states east of the Mississippi River.

Since red clover is normally cross-pollinated, the plants are mixed genetically. But few varieties exist, and the crop is usually referred to, according to its origin, as Michigan red clover or Italian red clover. In general, differences between strains according to origin are slight in the United States. Strains coming from southern Europe are definitely less winter-hardy than those commonly grown in the United States and Canada.

Improvement. Breeding for disease resistance has been one of the primary objectives in red clover improvement. As early as 1906 the Tennessee Agricultural Experiment Station selected a red clover resistant to the fungus anthracnose (*Colletotrichum trifolii*). Wherever red clover grows in the United States it is subject to the attacks of powdery mildew (*Ersiphe polygoni*) and the potato leafhopper insect (*Empoasca fabae*). The powdery mildew covers the leaves and makes dusty hay. The leafhopper causes the leaves to turn red and in severe cases to wither and die. The clover-root borer (*Hylastinus obscurus*) is responsible for much of the killing of red clover during the second winter of its growth.

The United States Department of Agriculture, in co-operation with several state agricultural experiment stations, has collected promising material for study and as a basis for further improvement. From this work have come superior strains of anthracnose-resistant lines of red clover.

At the Wisconsin Station progress has been made in the development of lines resistant to powdery mildew.

From the investigations under way it appears that red-clover improvement may be expected in the very near future. More work is being devoted to these studies than ever before.

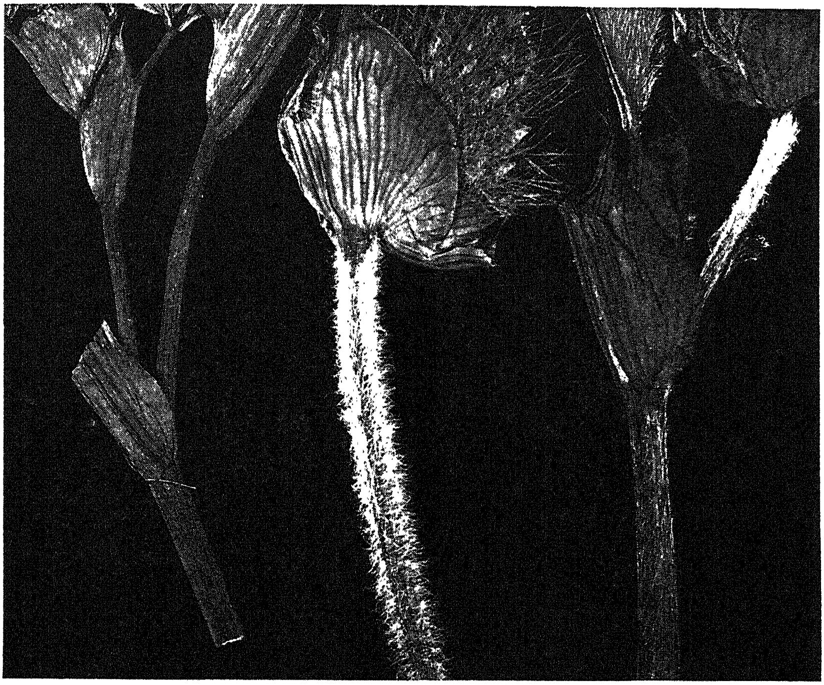

Figure 56. Domestic and foreign red clover stems. Hairy stem in center, a native plant; smooth stems on right and left plants from foreign seed. The hairy plant has proved more resistant to insect damage.

Midland is a new variety of red clover resulting from several years of breeding and testing by the United States Department of Agriculture in co-operation with the agricultural experiment stations of Montana, Colorado, Utah, Oregon, Washington, Idaho, Illinois, Iowa, Indiana, and Ohio.

The new variety is best adapted to an area embracing the southern two thirds of Iowa, the northern half of Illinois, Indiana, and Ohio, Pennsylvania, except the southeastern part, the southern half of New York, and Massachusetts, Connecticut, and northern New Jersey.

Cumberland, another new variety of red clover, shows resistance to southern anthracnose and crown rot. It will prove of especial benefit in the southern region of the red clover belt. This variety should be preferable in the warmer areas of the red clover belt to the Midland variety, which is not resistant to anthracnose.

Although these strains of clover show definite improvement, their distribution is limited. The average farmer still grows red clover with little consideration as to variety or strain. The improved strains mentioned above are listed to illustrate the principles of improvement and to indicate future possibilities.

Technique of Breeding. As stated before, red clover is normally cross-pollinated. In general, it is self-sterile, but self-fertile lines have been obtained.

Plants to be selfed may be isolated in a greenhouse, placed in an insect-proof cage, or a portion of the flowers placed in fine-mesh linen bags. It is desirable to rub the flowers gently each day to trip them and make certain that the pollen comes in contact with the stigmatic surface.

In crossing red clover, the flowers of the plant selected to be the female are emasculated, as described for alfalfa, or the operator may carefully remove the anthers with a pair of fine-pointed tweezers. Within 1 to 2 days after emasculation the pollen from the male parent is transferred to the stigmas of the flowers of the female. The flower heads are protected by bags or cages to prevent insects from bringing in stray pollen. In England, bumblebees are used to transfer the pollen from one plant to another. The plants are grown in a greenhouse and the bees are permitted to work upon them, so as to effect cross-pollination.

WHITE CLOVER

Because of its extensive use in pastures and as a lawn plant, white clover (*Trifolium repens*) is of great importance in the United States.

Little has been done in America to improve white clover. Most of our improvement has resulted from natural selection. In New Zealand, where extensive clover breeding has been continued for many years, improved strains have been developed. The Scandinavian countries also have made progress in white-clover improvement. Several promising lines have been developed and are being tested in the United States. More intensive forage breeding is the practice in America. At present the work is largely in the beginning stages, and, therefore, results are few. Doubtless, considerable improvement can be made by locating and isolating existing strains from native pastures. This method of improvement is the most promising and most rapid.

ALSIKE CLOVER

Alsike clover (*Trifolium hybridum*) is not so widely grown as red or white clover and has received little attention from breeders. In general, the plant is cross-pollinated and for the most part is self-sterile. The isolation of promising strains is a possibility in improvement. The technique is similar to that recommended for red clover.

CRIMSON CLOVER

Like alsike, crimson-clover (*Trifolium incarnatum*) is limited in production for lack of adaptation. The plant is cross-pollinated and is believed to be self-sterile. Little has been done to improve crimson clover and unquestionably it offers opportunity for fruitful breeding to improve its agronomic qualities.

SWEET CLOVER

Sweet clover (*Melilotus* spp.) has not been recognized as a desirable plant for as many years as the other clovers have been. As we have learned, the plant was regarded as an undesirable weed for years. Even today, in sections where alfalfa seed is produced, the sweet clover plant is very undesirable.

Improvement. Most of the improvement work with sweet clover has been the selection of promising strains. One of the most popular of the biennial white varieties is Grundy County White, first noted in Grundy County, Illinois, in 1917. The exact origin of the variety is unknown. The plant is early, erect-growing, with fine stems making for better forage. Arctic, another white variety, a Siberian importation, is a dwarf type noted for its winter hardiness.

Alpha sweet clover was developed by L. E. Kirk at the University of Saskatchewan. Kirk found the plants in a field of Arctic sweet clover in 1924, and he developed the variety by inbreeding and selection. The plants are low-growing, bushy, and produce a fine growth resembling that of alfalfa. Alpha does not produce sufficient growth to make it suitable except for the northern states, and in many cases it has failed here because of its susceptibility to diseases.

Hubam is an annual white sweet clover developed by mutation from the biennial species. This variety has been grown in Iowa to some extent but has been limited in its use.

Other white varieties are Madrid White, Iowa Late White, Ohio Evergreen, Illinois No. 8, Spanish, and Evergreen.

The yellow sweet clovers have not been studied as intensively as the White species. Zouave, a yellow-flowered variety developed at the University of Saskatchewan, has shown some promise because of its erect growth. Redfield Yellow, a United States Department of Agriculture development, has been popular with farmers preferring a yellow-flowered variety.

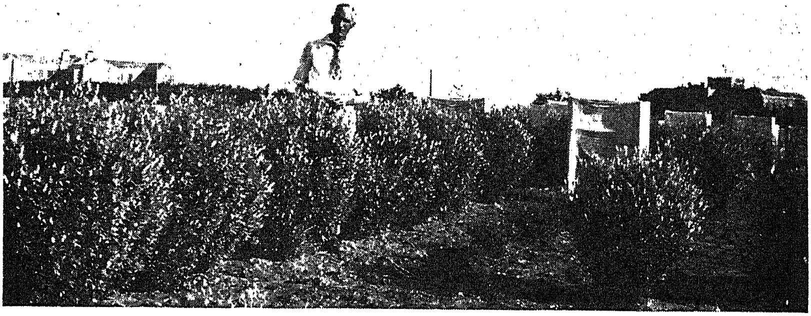

Figure 57. Alpha sweet clover plants. Note resemblance to alfalfa. The man in the picture is Dr. L. E. Kirk, the breeder of Alpha sweet clover.

Other yellow-flowered varieties are Albotrea, Madison County or Switzer, St. Louis Valley, Daghestan Yellow, Madrid Yellow, and Madrid.

Technique of Breeding. Since sweet clover is normally cross-pollinated, the strains are greatly mixed. Insects, particularly bees, produce much crossing between plants. The technique is similar to that outlined for alfalfa. The use of the suction method of emasculation is desirable and the use of a greenhouse aids greatly, as insects can be excluded and cross-pollination thus prevented. Plants are bagged to produce self-pollination much as is done with alfalfa. The most promising methods of improvement appear to be: (1) isolation of desirable strains; (2) selection for desirable types in inbred lines; and (3) hybridizing inbred lines for desirable characters in a new strain.

Objectives. Sweet clover has a characteristic bitter taste due to the coumarin content of the plant. This coumarin content is believed to be associated with toxic conditions which frequently develop from the feeding of sweet clover hay. Hence the development of coumarin-free strains appears desirable. The Minnesota and Wisconsin Agricultural Experiment Stations have made considerable progress in developing such a strain.

Other desirable characters of sweet clover are greater disease resistance, especially to anthracnose, finer type of foliage of higher feeding quality, greater winterhardiness, and the production of a smaller percentage of hard seed. The presence of hard seeds in sweet clover makes it difficult to eradicate under many conditions, since the seeds may remain in the soil for years and result in volunteer plants, when they are undesirable, as in an alfalfa seed crop.

THE SOYBEAN

The soybean *(Glycine hispida)* represents a different type of legume than the plants previously discussed in this chapter. For the most part, the legumes discussed are perennials and are grown for forage. The soybean is an annual that may be grown either for forage or for its seed, which is produced and handled much the same as a grain crop. In recent years an increased use of soybean oil has resulted in even greater interest in its production. From a crop of minor importance at the beginning of the Twentieth Century, the soybean has increased in acreage until it is now one of the leading farm crops.

Improvement. As indicated above, the soybean has been used primarily for forage or its seed. Accordingly, improvement has been directed toward these purposes. With the recent interest in soybean oil, more attention is being given to the production of varieties yielding a greater quantity of oil. To a limited extent soybeans are used for human food, and some effort has been made to secure varieties suited to this purpose.

For many years soybean improvement in America depended upon the introduction of varieties from the Orient. Many of these varieties were brought here and distributed to farmers without any further improvement. In a few cases selections were made from the introductions before their distribution to the growers. Such varieties as Manchu, Virginia, Laredo, Otootan, Wisconsin Black, Wilson-Five, Peking, and Ebony are representative of the early improvement efforts.

In 1929, the beginning of the intensive use of soybeans for crushing led to a demand for yellow-seeded varieties. Popular varieties with the crushers are Manchu, Illini, Dunfield, Mukden, Mandell, Delsta, Mandarin, Minsoy, Sciota, and Habaro.

With the increased use of soybeans for crushing, we may expect greater attention to the improvement of oil production and quality. From many analyses by the United States Department of Agriculture it has been shown that varieties may yield from 12 to 26 per cent of oil and that the quality of the oil may vary widely. The iodine number is a test used by the chemist to determine oil quality. The iodine number of linseed oil, the standard drying oil for most paints, is about 180. The iodine number of the oil from different varieties of soybeans ranged from 118 to 141. The higher the iodine number, the more likely is the oil to be suitable for paint.

In the extraction of the oil there remains a residue which may be utilized for livestock feeding. Extensive trials have shown that varieties range from 28 to 56 per cent protein. The higher the percentage of protein, the more valuable is the feed; as the plant breeder is working to develop varieties possessing a higher percentage of nitrogen.

Most of the breeding work has had, as an objective, higher yields. Only recently have the oil and protein contents of the varieties become problems of great importance. Every variety of commercial value has been developed through introduction or selection. The possibilities of hybridization are great, and we may expect advances in soybean breeding.

Once the prejudices of the American appetite are broken down, we may expect greater use of the edible varieties of soybeans. They appear most promising when grown and eaten as green beans. They are available in the fall of the year, when other green beans are not generally on the market. Promising varieties developed by selection or brought in as introductions are Hahto, Easycook, Kanro, Hokkaido, Higan, Chusei, Sousei, and Jogun.

Technique of Breeding. The soybean has a flower much like that of the pea and other legumes. The plant is normally self-fertilized, although some natural crossing does occur as evidenced by the mixtures of varieties.

Much progress has been made by selection within self-fertilized plants, and it is probable that much more can be done.

Selection, however, is limited by the variation that exists within the variety. The most hopeful method lies in hybridization.

The soybean flower is very small and, therefore, difficult to cross. Many workers find it best to emasculate the flowers from 3 to 7 o'clock in the afternoon. The flowers should be pollinated the same day they are emasculated. Emasculation is done before the flower has fully opened. All flower buds are removed from a branch, except those to be crossed. Those selected for crossing should show the purple or white of the corolla above the calyx. The anthers are removed with fine-pointed tweezers. Pollen is gathered from well-developed flowers just before they open and is dusted on the stigma of the emasculated flowers. Following pollination, the flowers are enclosed in a paper or cloth bag.

Objectives of Improvement. The yield of beans, forage, and oil has already been considered. The various important objectives may be summarized: (1) increased yield; (2) disease resistance; (3) yield of high-quality oil; (4) increase of protein content; (5) resistance to shattering; and (6) early maturity.

Increased yield is nearly always a desired objective of the breeder. Where the bean is used for forage the goal may be a greater yield of hay; but, in most cases, the goal is increased production of dry beans.

Breeding for disease resistance is a necessary part of any successful improvement program. Fortunately, the soybean has not been attacked by many very serious diseases. With its increased cultivation, however, diseases will have increased significance.

Breeding for a high yield of oil of superior quality is a problem of recent importance. With the range found in existing varieties, there is no doubt that improvement may be expected from an intensive program of breeding.

Resistance to shattering and ability of the plant to stand in the field after maturity are essential, if the combine harvester is to be used. The natural tendency is for the beans to shatter when mature. Much, therefore, remains to be done to improve existing varieties in these characteristics.

Early maturity will lead to the growing of soybeans farther north. Many sections of the country can not mature seed beans with the present varieties. As has been done so successfully with corn, we may expect the plant breeder of the future to push the soybean frontier farther to the north.

MISCELLANEOUS LEGUMES

In general, the principles enumerated for the legumes discussed apply to the entire group of legumes. No attempt will be made to treat each in detail but rather to list the more important types and varieties that are of agricultural importance.

THE COWPEA

The cowpea (*Vigna sinensis*) serves much the same purpose as the soybean. Most of the varieties have resulted from introductions and selections. Following the more extensive use of soybeans, it has decreased in importance, although, in some sections of the South, cowpeas are preferred to soybeans.

Iron, Brabham, Groit, and New Era have proved resistant to wilt and nematode attacks. It is probable that natural selection has contributed to the suitability of these varieties. Brabham is believed to be a hybrid between Iron and Whippoorwill, and Groit, a hybrid between New Era and Whippoorwill, although there is no proof of their ancestry. In California improved selections of Brabham and Iron are grown commercially. The United States Department of Agriculture developed Victor by crossing Groit and Brabham. Suwanee, a variety of unknown origin, is proving very successful in Florida.

THE FIELD PEA

As already explained, the field pea (*Pisum sativum*) is best suited to cool, moist growing conditions. In recent years the crop has been used in the South as a cover crop and for green manure. Austrian Winter, the principal pea used in the South, is susceptible to diseases and must be improved if it is to be continued as a successful variety. The United States Department of Agriculture is co-operating with several of the southern agricultural experiment stations in programs of improvement.

THE VELVET BEAN

The Florida velvet bean (*Stizolobium deeringianum*) is an important legume in the warm southeastern part of the United States. Velvet beans have been grown since their introduction into Florida previous to 1875. For many years the crop failed to mature farther north, and production was largely confined to Florida.

In 1906, Clyde Chapman selected an early-maturing plant which was the basis for the earliest velvet bean known. This selection, named Georgia, was followed by a much wider growth of the velvet bean. In 1911, a Mr. Blount selected an early variety which he named Alabama.

A so-called bush velvet bean was selected in Georgia about 1914. This variety grows as a bush or bunch-like plant and lacks the climbing characteristics of the common velvet bean. From this plant a white-seeded mutant has been selected.

Workers at the Florida Agriculture Experiment Station crossed the Florida velvet bean (*Stizolobium deeringianum*) and the Lyon velvet bean (*S. niveum*). The new variety known as Osceola is a vigorous, high-yielding variety capable of maturing as far north as central Georgia.

The velvet bean offers opportunity for great improvement in plant type, yielding ability, earliness of maturity, disease resistance, and quality of forage.

THE LESPEDEZAS

The lespedezas are relatively new in this country. They consist of two groups, the annuals and the perennials. The two annual species of importance are *Lespedeza striata*, the common lespedeza, and *L. stipulacea*, or Korean lespedeza. The perennial type *Lespedeza sericea* offers the usual advantages of a perennial over an annual type.

Without doubt much can be done by selection in improving the present varieties of lespedeza which are known to be a mixture of types, especially as to an unpalatable tannin content.

The United States Department of Agriculture introduced a rank-growing variety from Kobe, Japan. The variety known as Kobe is somewhat earlier than Tennessee 76.

Of the Korean lespedezas several introductions have been made from Manchuria. One of these named Harbin is extremely early, having matured seed as far north as Winnipeg, Canada. An early form U. S. No. 19604 has been released for growth in northern Iowa and Illinois and adjacent areas. It is much like the standard Korean, except that it is earlier.

The perennial lespedezas include several species. *L. sericea* is being studied intensively and selection offers great promise, as the plants show wide variations. Since the tannin content of lespedeza is high, the breeder seeks plants with a lowered percentage. The fineness of the plant growth also offers opportunities for improvement. Much progress is being made in the selection of improved types.

BUR CLOVER

The bur clovers belong to the genus *Medicago* and thus are closely related to alfalfa. Spotted bur clover (*M. arabica*) has been improved by selection. Manganese bur clover was selected by a Mr. Andrews of eastern Alabama. Another variety, early Southern bur clover, was selected in South Carolina by A. F. Ruff. Both these varieties were earlier maturing than the ordinary bur clovers.

California bur clover (*Medicago hispida*) has been subjected to selection by workers of the United States Department of Agriculture, and improved types have been released from the United States Plant Introduction Garden at Chico, California. The Texas Agricultural Experiment Station has made selections of the California bur clover. The Texas Station has developed a spineless variety for use in sheep pastures.

The great variability in the bur clovers indicates the possibilities of their improvement through further selection.

THE VETCHES

Many species of vetch are available, but *Vicia villosa*, hairy vetch and *V. sativa*, common vetch, are the most widely grown.

The Oregon Agricultural Experiment Station in co-operation with the United States Department of Agriculture has led in the improvement of the vetches. This station has produced a variety of hairy vetch which lacks the heavy pubescence of the *villosa* species. This variety is widely grown in Oregon.

Selection within the common vetch has resulted in a white-flowered variety of superior vigor and winterhardiness.

As the vetches are not grown extensively, relatively little work has been done to improve them. The work of Schoth at Oregon, however, indicates the possibilities of simple selection and it appears possible to develop varieties better able to grow under drier and cooler conditions.

THE FUTURE OF LEGUME IMPROVEMENT

It should be evident to the student of agriculture that in general the legume species have not received the attention they deserve. As with the grasses, much progress should be possible as a result of intensive programs of selection to find the superior types that already exist within present types. Except in a few instances already mentioned in this chapter, little has been done to improve our legumes. It is not unreasonable to expect that experiment stations will devote more time to breeding investigations with legumes in the coming years. It seems likely that such work may be expected to result in improved varieties more nearly suited to the needs of the farmer as well as adapted to the environment in which they are grown.

Suggestive Questions

1. Classify the various legumes as to mode of pollination.
2. What is meant by "tripping" an alfalfa flower?
3. Who was Wendelin Grimm?
4. Why is Grimm alfalfa becoming less popular?
5. Describe the suction method of emasculating flowers.
6. What are the objectives in alfalfa breeding?
7. How could one use the bumblebee in clover breeding?
8. The plant of what sweet clover variety resembles alfalfa?
9. What weather conditions favor seed setting of alfalfa?
10. What is responsible for the bitter taste of sweet clover? Of lespedeza?

Suggestive Problems

1. Draw a typical legume flower and label the parts.
2. Make a collection of soybean varieties adapted to your region. Label as to variety, length of growing season required, and use of the variety.
3. Obtain legume plants of different species. Emasculate the flowers and make crosses by transferring pollen from a plant selected as the male. Bag properly and harvest the mature seed.
4. Place soybeans in a lard or similar press. Extract the oil. Note its color and flavor. Enumerate the uses that may be made of such oil.
5. Examine alfalfa flowers in the field. By pressing your finger or a pencil on the keel of the alfalfa flower cause it to trip. Explain what happens.

CHAPTER XII

THE IMPROVEMENT OF FRUITS

The term fruit as used here applies to the group of plants cultivated for their edible fruits. As we have already learned, a kernel of wheat is a fruit; a bean is a fruit. The application of this word fruit is restricted by the layman to those more or less fleshy plant parts which for the most part are edible in the uncooked state. As it is impossible to discuss all fruits, our discussion will include the more common types, that is, apples, pears, stone fruits, citrus fruits, strawberries, blackberries, raspberries, currants, gooseberries, and grapes. Nearly every farmer produces one or more of these varieties.

THE APPLE

Apple-breeding is not the relatively simple process of crossing two varieties, as with wheat or oats, and then selecting improved combinations within a short space of time. As stated aptly in the 1937 Yearbook of the United States Department of Agriculture:

> "Apple-breeding is a task that requires not only great patience, but ability to look well into the future. In most sections of the United States at least 10 to 15 years are required to grow an apple from seed to bearing age and to obtain an accurate evaluation of it. To propagate and test a promising kind will require an additional 10 to 12 years. Not less than 25 years, therefore, are usually required from the time a cross can be fully evaluated. Additional years must then elapse before commercial orchards come into fruiting. Thus it usually takes from 30 to 40 years between the planting of the original seed and the production of commercial crops even of a very superior apple. Apples, originating from the earliest breeding investigations in the United States, begun as far back as 1880, are just now coming into prominence; those from the breeding work of 20 or 25 years ago are not fully tested. It is easy to see, then, why few of our popular commercial varieties have as yet resulted from modern breeding work. There is, however, every prospect that varieties superior to those now in use will result from the many thousands of hybrid seedlings now under test at various research centers."

Botany. The apple belongs to a Family called *Malaceae* and to the genus *Malus*, sometimes classed in the Family *Rosaceae*.

The flowers of the apple and the pear are much alike. The calyx consists of 5 sepals at the base of the blossom; the corolla (the flower) of 5 white or pink petals; the stamens bearing the pollen, usually 20 in number; and the pistil with its stigmatic surface to receive the pollen. As in other plants discussed, the pistil contains the ovary and develops into the fruit.

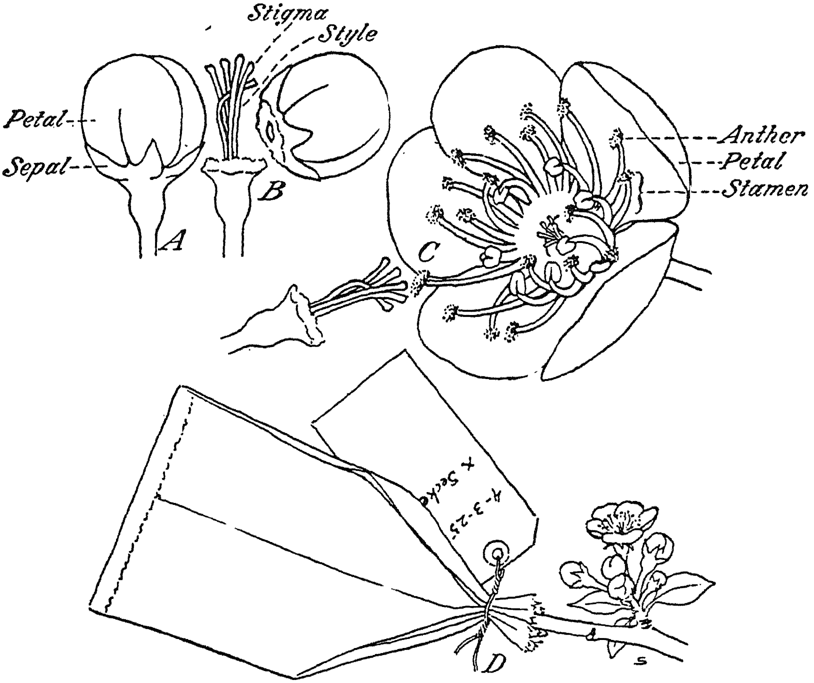

Figure 58. Steps in hybridization of apples and pears. A, bud in proper stage for emasculation; B, after emasculation, showing petals, sepals, and stamens pinched off and removed; C, an open flower, showing the flower parts that are removed in emasculation; D, the method of protecting the emasculated flowers from chance pollination.

Improvement by Selection or Bud Mutations. Fortunate indeed is the breeder who discovers a mutant branch or bud on an apple tree when the mutant produces a new and improved type of fruit.* Since the apple can be reproduced vegetatively, it is possible to perpetuate the new type and at one stroke success may come to the breeder. It must be remembered that desirable changes occur infrequently and that of those occurring

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* A mutant is the result of a genetic change that results in a new form or type of fruit.

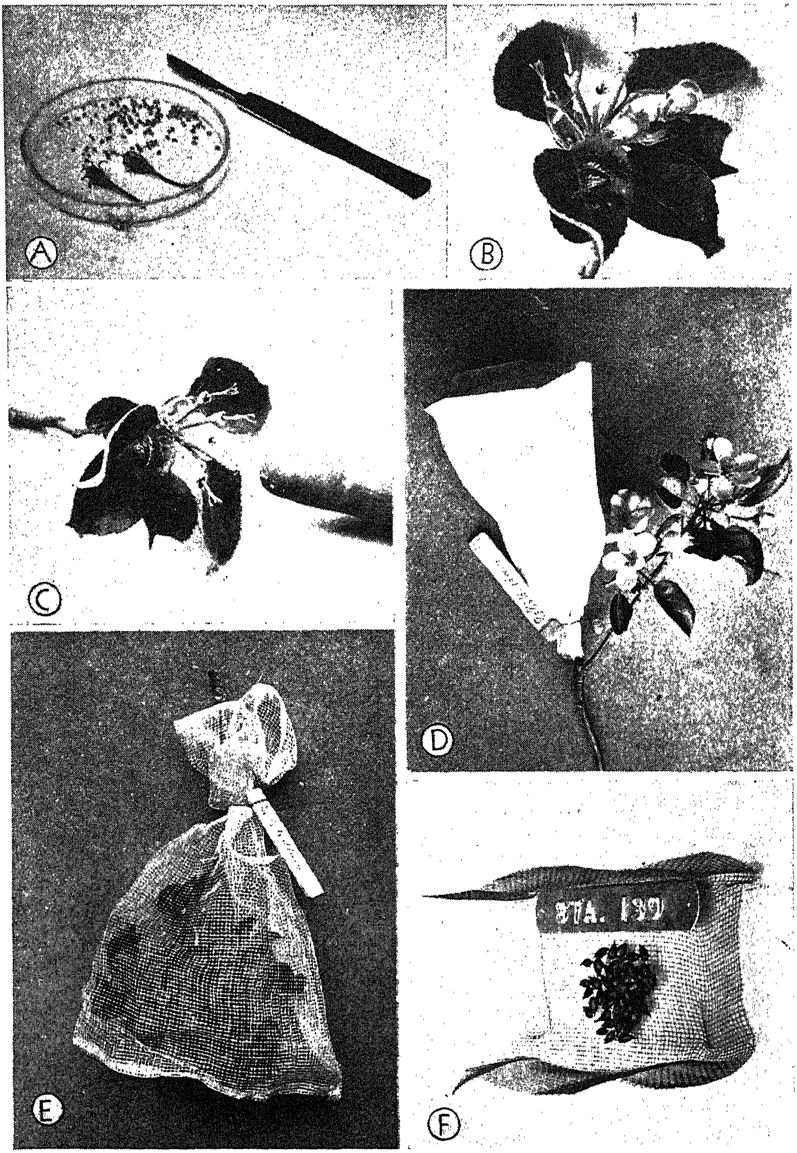


Figure 59. Steps in apple breeding: A, collecting pollen from unopened clusters; B, blossoms emasculated and ready for the application of pollen (note that the pollen-bearing organs have been removed); C, applying pollen to the pistils of the emasculated flowers; D, pollinated flowers protected from chance pollination by covering with paper bags; E, mesh bags used to protect the fruit that has been set; F, seeds from controlled pollination, protected by mouse-proof screen for stratifying in soil.

the chances of finding them when they occur and being able to realize upon them are very remote. Nearly everyone has heard of the Delicious apple and the story of its origin as a mutant. While such changes may not occur often, the breeder is always on the alert to discover such miracles when they do happen.

Many strains are known to have originated as bud mutations. There are more than 30 red strains of the Delicious variety. More than 15 red strains of Rome Beauty are known, 20 strains of Winesap, 8 strains of Stayman Winesap, and several strains of McIntosh, York Imperial, Jonathan, and other leading varieties. In several cases the improved strains have largely replaced the original variety from which the mutation came.

Mutations in color are most evident to the breeder. It is known, however, that similar mutations occur affecting maturity, size, shape, and flavor of fruit.

Even the amateur plant breeder may discover a new and improved apple variety, if he but searches among his fruits. The selection, propagation, and testing of bud mutations offer the most rapid method of improving present varieties; but, of course, it is limited largely to chance. Any improvement program should recognize the possibilities of improvement by the testing of bud mutations as a part of the work. To produce new and superior sorts, the hybridization method offers greatest possibilities.

Improvement by Hybridization. The apple seed represents a heterogeneous mixture. When planted, the seed is likely to produce a wild-like crab of inferior quality. It is not uncommon to graft the desired apple variety on a root which genetically is of no value for fruit. As a result of the mixed genetic character of the seed, varieties are perpetuated asexually, using cuttings for grafting on a strong root.

Apples are crossed very much the same as wheat and oats. Having chosen the two parents for mating, the operator proceeds to make the cross. In most cases the stamens must be removed from the flower to be crossed before the flower has opened, and, usually, when the flower is in the so-called balloon stage and the petals still cover the inner flower parts, as illustrated in Figure 58, A. A small knife may be used to make a cut at the base of the sepals. The flower parts are removed, taking with them the stamens, and leaving the pistil intact, as shown in B. Some operators prefer to pluck the petals and to remove the anthers with a pair of tweezers. Following emasculation, the flower is covered with a bag as illustrated.

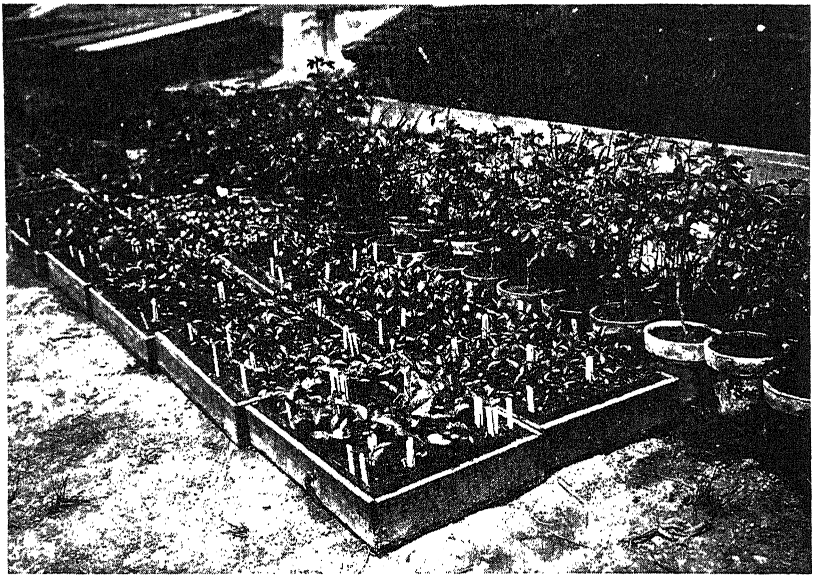


Figure 60 (a). Steps in apple breeding; young seedling trees grown in flats prior to setting in the field.

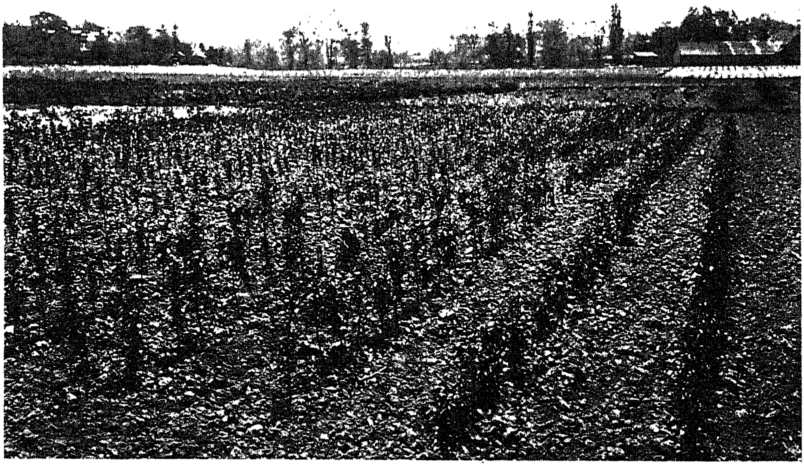


Figure 60 (b). Steps in apple breeding; young trees growing in nursery.

A day or two after emasculation the pollen from the male parent may be applied to the pistils. Pollen must be applied before the stigmas turn brown. The pollen is taken from the male parent in much the same manner as described for emasculation. The anthers are stored in a moderately warm, dry place to ripen for 24 to 48 hours. The pollen is applied to the stigmas of the emasculated flowers with a fine camel's-hair brush, sterilized in alcohol between pollinations. Following pollination, the bags are replaced to protect the flowers. As soon as the stigmas are brown, the bags may be removed to permit the hybridized fruit to develop normally. The fruit may be harvested when slightly miniature to avoid loss from dropping.

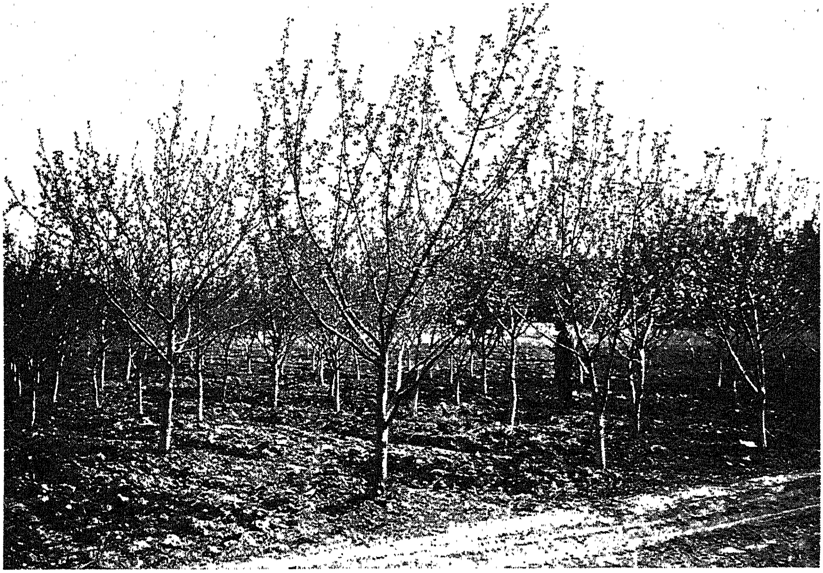


Figure 60 (c). Steps in apple breeding; a hybrid orchard in fruiting. At this stage undesirable seedlings can be eliminated.

The hybrid apple is placed in cold storage or in a cellar until spring. The seeds are removed and planted in the nursery. Some breeders remove the seeds in the fall and store them in properly labeled bags. Another method is to bury the seed and carry it through the winter outdoors. When a greenhouse is available the seeds may be grown in flats until about 3 to 4 inches high when they are transplanted to the field for the final phase of testing their value.

The seedlings are grown in the nursery for about 2 years and then transplanted to the orchard where they will have sufficient space to develop into trees of bearing size.

Time may be saved in testing the new hybrid by budding or grafting from the young seedling trees to older bearing trees. On a vigorous tree such a graft may give fruiting records within 3 to 4 years from the date of budding or grafting. In about 5 years one can measure the probable value of the fruit while 8 to 10 years are required, if fruit is produced on the seedling tree.

Objectives in Breeding. The objectives vary according to the section of the country. For example, in northern states a primary objective is to obtain greater winter hardiness. Without doubt one of the most important objectives is to develop greater disease resistance. The diseases scab, blotch, bitter rot, fire blight, and cedar apple rust do enormous damage. Different varieties of apples show varying degrees of resistance to these diseases, indicating the possibilities of breeding for their control.

One of the greatest causes of damage is the susceptibility of apple varieties to late spring frosts and freezes. Delaying the blooming period a week to 10 days is a highly important objective of the breeder.

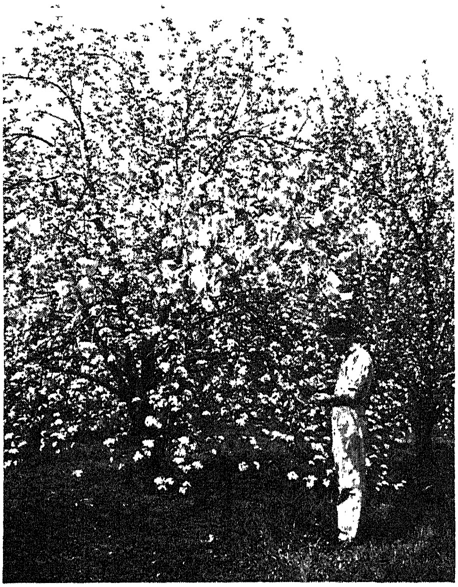


Figure 61. Cross-pollinated apple blossoms protected under glassine bags and labeled.

The production of high-quality fruit capable of storage without too rapid loss of quality is important. Some of the most promising varieties are notoriously poor shippers and so are limited to local consumption. Other varieties have weak trees subject to injury from storms or from spray applications. These and many other problems make the apple a fruit which offers great opportunity for further improvement.

THE PEAR

As stated above, the pear is related to the apple. It belongs to the same family, but to the genus *Pyrus*. From the 1937 Yearbook of the United States Department of Agriculture we quote:

> "All the known species of pears are native to Europe, Asia, and northern Africa. There are no native American species, and none is known in the Southern Hemisphere. Within these species and varieties, however, we have all the characters needed to produce pears suitable for this continent—fruit of high quality, winter-hardy, and, above all, resistant to fire blight, the scourge that has made the growing of superior pears impossible throughout much of the United States and difficult even in favored regions. To combine these characters properly constitutes a great challenge to the American plant breeder. He has made a small but promising start, and, if, with the raw material available, the problem is not solved within the next century, it will indeed be a reflection on his scientific ability and energy."

Improvement. Most of our pear varieties have been introduced from other countries. Like the apple, the pear may produce bud mutations resulting in improved sorts. Because of its more limited growth not nearly as much improvement has been made as in the apple.

Hybridization appears most promising. The flower of the pear is much like that of the apple, and methods of emasculation and pollination are like those described above.

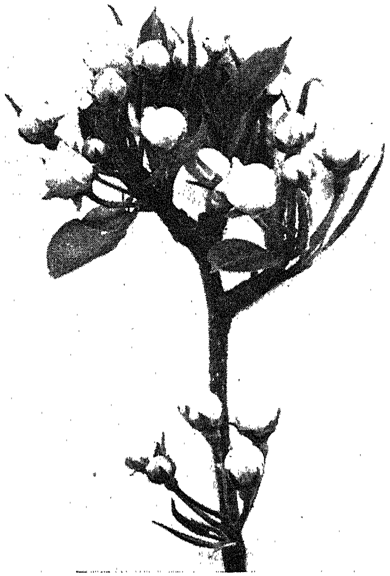


Figure 62. Blossoming spurs of pears in proper stage of emasculation.

Considerable work has been done by several experiment stations. The California Station has sought to obtain superior varieties of *Pyrus communis*. The Bartlett variety has been crossed with Winter Nelis, Easter Beurre, Comice, Hardy, Anjou, P. Barry, and Bosc.

Other states doing considerable work in pear improvement are Iowa, Michigan, Minnesota, New York, Georgia, Oregon, and Tennessee.

Fire blight, a disease which destroys many pear trees is the object of intensive research at the Southern Oregon Branch Experiment Station. Here practically all known species of pears have been studied. Considerable progress has resulted. By mass selection, seedlings of *P. communis* have been found resistant to blight. Of 10,000 seedlings, 10 were highly resistant and, when pollinated with other resistant varieties, transmit a high degree of resistance.

The United States Department of Agriculture is doing intensive breeding work with pears. Several thousand seedlings from crosses have been tested and it appears that blight-resistance has been combined with good fruit characters.

Objectives of Breeding. As indicated above, the primary objective of pear breeding is to secure fire blight resistant varieties. Fire blight has destroyed most of the pears in many sections of the country.

Improved winter hardiness, as with apples, is greatly needed. The northern states need varieties capable of withstanding the long, cold winter. The more hardy varieties are likely to be low in table quality. Much work is required to improve the table quality of the more hardy varieties. The real high-quality pear is limited to those sections of the country having mild winter temperatures.

THE STONE FRUITS

The term stone fruits is applied to those fruits whose fleshy exterior covers a hard pit, or stone. The common types are peaches, apricots, plums, and cherries. Within the plum group are included prunes which are essentially dried plums.

Botany. Most botanists place the stone fruits in the Family *Amygdalacae* and in the genus *Prunus*. The fruit arises from a one-celled ovary whose fleshy, juicy wall forms the edible part of the fruit. The true seed is enclosed within a stony portion embedded in the fleshy fruit. The fruits may be smooth, as in the apricot, plum, and cherry, or it may be hairy as in the peach. The size, shape, and color vary with variety and species.

Breeding Technique. In general, the methods of breeding the stone fruits are similar to those employed with the apple and the pear, as their characteristics are much alike.

To have pollen ready at the proper time it is common to place shoots in a greenhouse or warm room so as to force them to bloom. When the flowers open, the stamens are removed and stored in containers to dry at a room temperature of 65° to 70° F. As soon as the stamens are dry, the anthers break open and the pollen is removed easily. The collected pollen is stored in a dry, cool place in boxes or bottles from which it is removed when making the cross.

The flowers to be used for females are emasculated before pollination by cutting the calyx cup with a sharp knife or the nails of the thumb and first finger and the entire corolla with its three rows of stamens is removed at one stroke, leaving the exposed pistil. Some varieties of peaches, plums, and cherries are already self-sterile. Unless one is certain of this condition, it is better to emasculate all flowers.

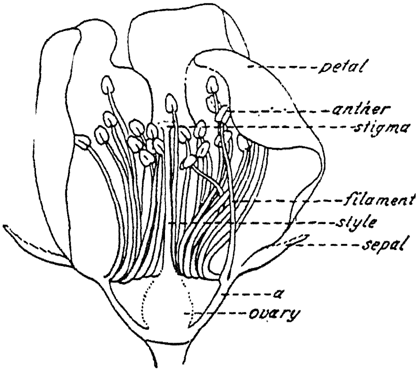


Figure 63. Section through a peach flower showing arrangement of floral parts. By pinching through the calyx cup at a with the thumb and the first finger, sepals, petals, and stamens are all removed in one operation, leaving the single pistil.

If emasculation is done just before the anthers burst, the crossing may be done at once. The male pollen is applied with a camel's-hair brush or with the tip of the finger. Care must be taken to sterilize the brush and the hands, if several different crosses are made.

Following pollination, the flowers are placed in glassine or paper bags fastened to the twigs. Some workers use a very heavy grade of paper bag of fairly large size, so that the sides will not collapse and injure the delicate pistil. Shortly after fertilization the style withers and darkens. At this time the paper bag is removed and is replaced with an open-mesh bag of coarse cheesecloth or linen to protect the maturing fruit.

Upon maturity the fruits are harvested and the stones removed. These are dried in a place free from molds. Most stone fruits must pass through an after-ripening period of 2 to 3 months at low temperatures. The stones may be soaked in water for several hours and placed in moist sand outside during the winter or, if facilities are available, placed in cold storage for 2 to 3 months at a temperature of about 40° F.

The seedlings may be grown by either of two methods. If one wishes to insure a high percentage of growth, one may remove the seeds by carefully cracking the pits. The seeds are sterilized with a disinfectant and placed in small bottles on sterile nutrient agar. As soon as the seedlings are well started they are removed to pots or into the nursery. On a larger scale, it is common to plant the stones directly in pots in the greenhouse or nursery. Some workers do not crack the pits but place them in the field in the fall, permitting nature to provide the change necessary for growth in the spring.

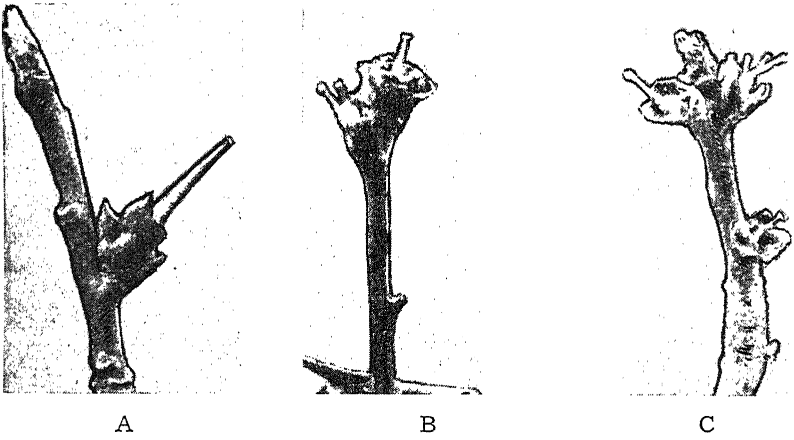


Figure 64. Peach flower after emasculation and fertilization. The single pistil (A) is normal, but occasionally, in some varieties and under certain nutritional conditions, two (B) or more pistils (C) may develop in a single flower.

Young seedlings may be planted in test blocks in rows 10 feet apart with the trees 5 feet apart in the row. After 3 to 4 years it is possible to study the fruit characters. As a rule, about 5 years must elapse before preliminary data are obtained and the trees can be propagated. About 15 to 20 years, therefore, must elapse before a full evaluation of the new hybrid is possible.

THE PEACH

Since the peach is limited to sections of mild winters, breeders in northern states spend much time and effort attempting to develop varieties that possess winter hardiness. Sub-zero temperatures are likely to destroy the fruit buds of most of our peach varieties. Another temperature relationship of great importance is the damage resulting from late spring frosts. It is not uncommon for these late frosts to come after the peaches start to flower, at which time they are easily destroyed. There is need for the development of later-blooming varieties.

As is often the case with many plants, the more cold-resistant varieties often lack the desired quality of fruit. There is decided need for improved quality of fruit both for shipping and for canning purposes. Often the highest quality fruit varieties are relatively low yielders.

Much work is under way in the various agricultural experiment stations. It appears that the future is promising, if workers can make use of the breeding material now available.

THE APRICOT

The apricot is one of our most prized fruits, but it is not so widely grown as the peach.

The apricot does not ship well and, so, varieties which remain firm in handling are desired. Most apricots soften very quickly after they are harvested, thus making their shipping for long distances very hazardous.

Apricot varieties possess more cold resistance than peaches. They also bloom as soon as the weather warms, a habit which frequently results in bud destruction by late frosts. Varieties of apricots may be grown in the colder areas of our north-central states. There is need for improvement in the quality of the fruit, as many of the hardy varieties are poor fruit types. During recent years many introductions from Europe and Asia have proved of value and the apricot is now known far north of the region where peaches can be produced.

More introductions should be made and a careful study of existing types may be expected to yield valuable information. Following introduction of improved varieties, crosses may be made much the same as with the peach.

THE PLUM

Many types of plums are available in the United States. Delicious varieties may be grown in the coldest sections of our country. Many varieties are possessed of qualities commonly ascribed only to the peach and apricot. The ease with which the plum is grown, even in a small backyard, leads one to wonder why this fruit is not more widely utilized. It is not uncommon to find many farms entirely free from tree fruits. The plum is one fruit which requires so little attention that it is extremely unfortunate that more people do not make use of it.

The better sorts of various countries have been introduced. Varieties of the European plums, *Prunus domestica*, are the most important and widely known. Important varieties are Green Gage, Yellow Egg, Lombard, Italian Prune, Azen, Sugar, Imperial Epineuse, Tragedy, Bradshaw, and Golden Drop. Unfortunately these varieties succeed only under favorable conditions and are not successful where the winters are cold and the summers hot and dry.

Figure 65. An improved variety of prune.

The damson plum (*Prunus insititia*) was introduced from the Old World. This plum is a hardy vigorous type, suitable for preserves and jams. Important varieties of the blue damson are Shropshire and French.

The Japanese plum (*P. salicina*), introduced from Japan, resembles the native American types. Varieties are widely adapted, succeeding everywhere except in the very coldest climates. Important varieties are Kelsey, Burbank, Abundance, and Satsuma.

Many American species of plums are known. *P. americana* is the most widely-distributed species, being found in a large part of the United States. The trees are extremely hardy and persist where winters are cold and summers are hot and dry. Important varieties are DeSoto and Weaver.

Several other species of lesser importance are grown in America, some native and some introduced.

The vast number of types of plums available offers a wealth of material for the fruit breeder. It is fair to state that, while great progress has been made, there is great opportunity for further work.

Probably the greatest need in plum breeding is to develop high-quality fruit capable of growing under more adverse conditions of climate. Many of the plums grown in the middle west are of such poor quality that it is easy to understand why so many persons do not regard the plum as an important fruit.

Hardiness is desirable and such varieties are available, but they are not of as good fruit quality as desired. It would be highly desirable to be able to grow a variety like the Green Gage in the Dakotas. Doubtless bud mutations exist and search should be made for them. The crossing of native varieties with introduced species has not succeeded because of a difference in chromosome numbers. If it were possible to combine these species, there would be greater hope for hardy, high-quality varieties. Much progress is being made and many splendid varieties are available except in regions where climatic conditions are most severe.

THE CHERRY

Our cherries belong to two species, (*Prunus avium*) and (*P. cerasus*). The former is the sweet cherry grown primarily in the West, where the winters are mild, and the latter is the sour cherry, capable of growing under severe winter conditions.

Sweet cherries are used to a large extent as a fresh fruit, being shipped much the same as fresh peaches. Sour cherries are produced primarily for canning and are commonly referred to as pie cherries.

Cherries are not widely grown. Most of the sweet cherries are grown in the Pacific and Intermountain States of the West, while sour cherries are found largely east of the Mississippi River, particularly in the Great Lakes Region. Sour cherries will grow under conditions of colder winters than the peach but usually it is rather short-lived, and this fact discourages its greater cultivation. Important varieties of sweet cherries are

Coe, Ida, Elton, Wood, Black Tartarian, Windsor, Republican, Bing, Lambert, Yellow Spanish, and Napoleon. The popular varieties of sour cherries are Early Richmond and Montmorency.

As intimated above, there is great need for high-quality sweet varieties that are sufficiently hardy to be grown more extensively. Even the sour-cherry varieties do not succeed well except in a rather restricted area. Because of diseases, cherries are not grown to any extent in our Southern States.

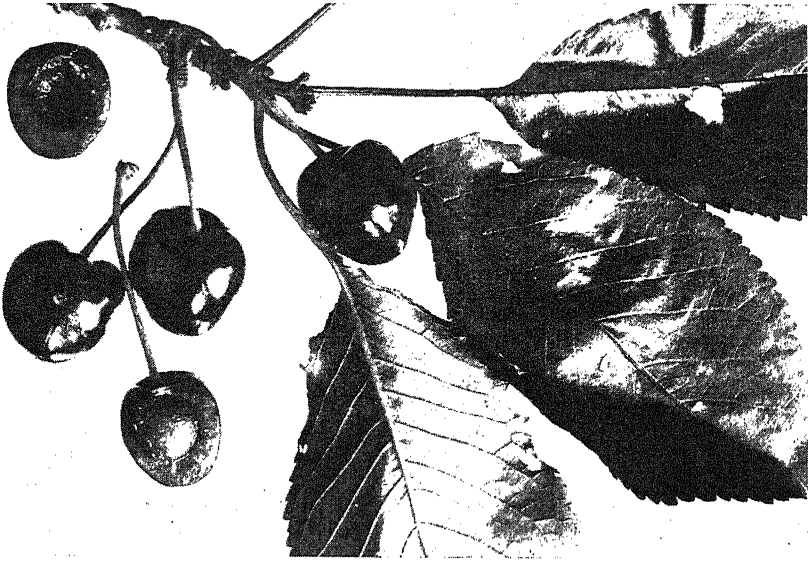


Figure 66. Sweet cherries are more or less heart-shaped and are sometimes referred to as heart cherries. Black Tartarian, shown above, is a variety of the gean type with dark flesh and reddish juice. The bigarreau type is similar in appearance but has firm flesh.

The quality of the fruit of the sweet cherry does not remain firm as long as desired. Many fruits crack on the trees and become a loss. Varieties whose fruit would ripen over a longer season would be desirable from the grower's viewpoint.

New introductions as well as hybridization offer possibilities that may lead to greater improvement of hardiness, quality, and disease resistance.

CITRUS FRUITS

Citrus fruits are not grown as widely as the fruits previously discussed. For this reason they have not been discussed in *Agri-*

culture III, and it is desirable to present here a few facts relative to the species and varieties of these fruits.

The citrus fruit-producing areas of the United States are limited to those sections where the climate is subtropical. As shown in the figure below, production is primarily in the extreme South and Southwest.

The American consumer is able to obtain a supply of fresh citrus fruits the year around.

TYPES OF CITRUS FRUITS

The citrus fruits possess diverse morphological characters. They belong to the Family *Rutaciae* and to the genus *Citrus*.

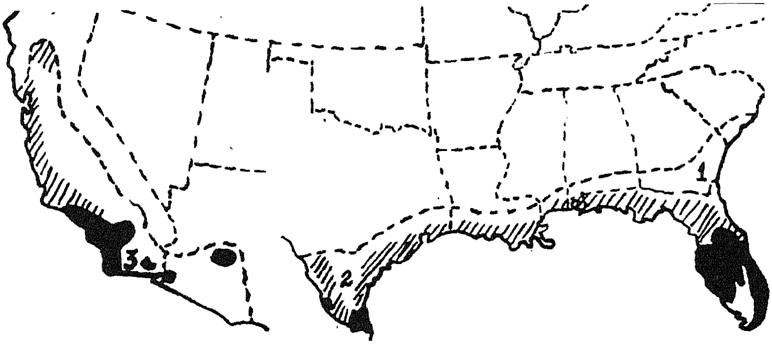


Figure 67. Citrus producing areas of the United States. Solid black denotes areas of commercial production of sweet and tangerine oranges, grapefruit or acid citrus fruits (lemons or limes). Shading denotes areas producing satsuma oranges or minor quantities of other citrus fruits. The dotted boundary lines indicate the approximate northern limits of the three subtropical regions: (1) Southeastern humid, (2) Central irrigated, and (3) Southwestern irrigated.

Some of the types of citrus grown for their fruits or as rootstocks follow:

Sweet orange,	*Citrus sinensis*	Grapefruit,	*C. grandis*
Sour orange,	*C. aurantium*	Pummelo,	*C. grandis*
Tangerine orange,	*C. nobilis* var. *deliciosa*	Citron,	*C. medica*
King orange,	*C. nobilis*	Lemon,	*C. limonia*
Satsuma orange,	*C. nobilis* var. *unshin*	Lime,	*C. aurantifolia*
Shaddock,	*C. grandis*	Kumquat,	*Fortunella* spp.

Most of these fruits are well known to nearly everyone, but a few are less widely used. A short description of characteristic differences and important varieties follows.

The qualities of the various citrus fruits are dependent on the combinations of sugars, acids, glucosides, esters, and peel oil. The sugars and acids are the basic materials of the fruits and the various combinations give the variations from sour through tart, sweet, and insipid. The glucosides impart the bitter principle. The peel oil contains the aromatic qualities of the fruit.

Sweet Oranges. In the sweet orange the sensation of sweetness predominates with a pleasing trace of tartness evident. As indicated above, the varieties grown in California produce oranges throughout the year. The navel oranges are of high quality and very sweet. The principal varieties in California are Washington Navel and Valencia.

In Florida the navel orange is not adapted. Important varieties are: early varieties, the Hamlin and Parson Brown; midseason, Homosassa and Pineapple; late, Valencia.

Sour Oranges. This type of orange is used for rootstocks in all the citrus-growing sections. It is highly resistant to cold and to root and crown bark diseases. All citrus types may be budded upon sour orange rootstocks except Satsuma, kumquat, and limes.

Tangerine Oranges. Of the mandarin, or free-peeling, oranges, tangerines are characterized by a pleasing tang which is due to chemical compounds known as esters. The principal variety of tangerine is Dancy, grown extensively in Florida, and, to a limited extent, in California. The King and Satsuma oranges in this group possess taste qualities similar to those of the sweet orange. The Satsuma orange was introduced from Japan into Florida in 1876. Most of the oranges grown are of the Owari variety.

Grapefruit. The grapefruit has become one of the nation's leading breakfast dishes. Its characteristic bitter taste is due to a glucoside. The peculiar flavor, together with the mild acidity, makes the fruit especially suitable as a breakfast appetizer. March, a seedless type, is the leading variety. The pink-fleshed Foster and Thompson are desirable on account of their earliness.

Pomelo (pummelo). The pomelo is a salad fruit. Its flavor is due to a very slight acidity and the presence of only a very little glucoside. The flavor is more desirable than that of the sour shaddock to which it is closely related.

Citron. The citron is grown for preserving, although its production is minor in comparison with most of the citrus fruits.

Lemons and Limes. Both lemons and limes are characterized by their high acidity. The "lime" taste is the result of a particular glucoside. The peel oil of lemon and lime adds to their desirable qualities, and is much used in food industries.

The entrance of citrus scab was a severe blow to lemon culture in Florida. Perrine, a hybrid variety produced by the United States Department of Agriculture, has proved resistant to scab and anthracnose and promises to be an important variety. Meyer, introduced from China, is noted for its frost resistance. In California the principal lemon varieties are Eureka and Lisbon.

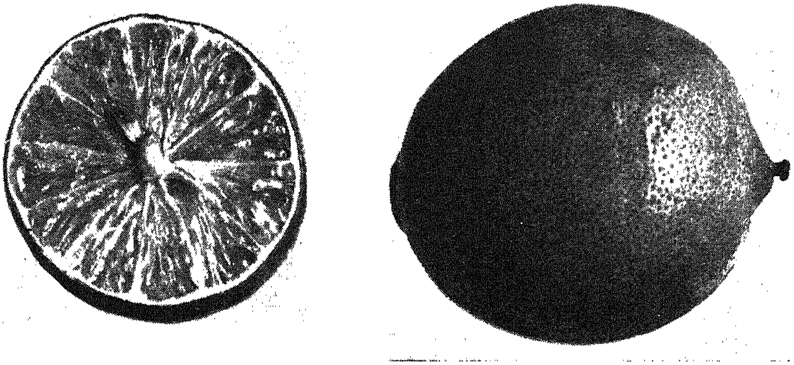


Figure. 68. Perrine, a hybrid lemon resistant to scab.

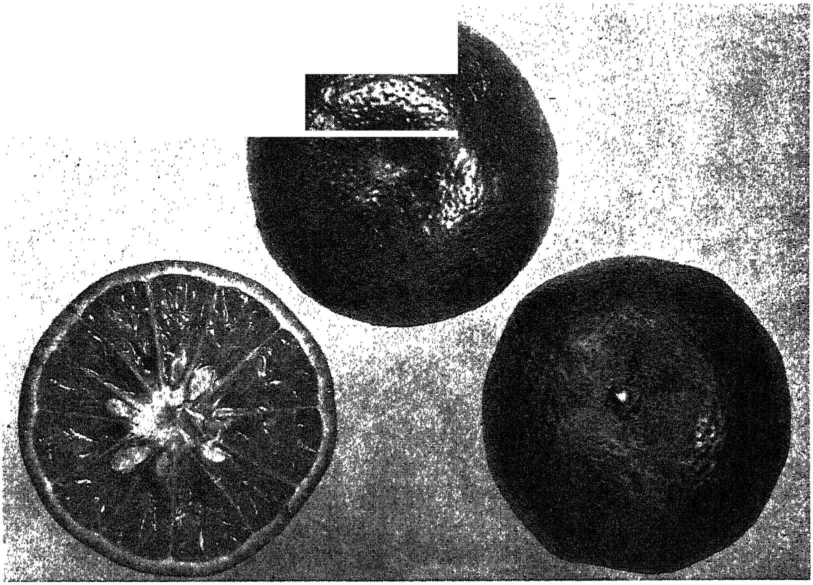


Figure 69. Orlando (Lake), an improved variety of tangelo.

Kumquat. The kumquat is used both as a preserve and in table decorations. In some cases it is eaten out of hand. The fruit is not widely known, as most of the people of the United States have never seen a kumquat.

Hybrid Types. Crosses between various citrus fruits have led to several promising types. The Tangelo, a cross between the grapefruit and the tangerine orange, has many fine fruit qualities. The fruit of the Tangelo resembles the grapefruit in structure and juice quality but has the rind, flesh, and seed color of the tangerine. The Umatilla and Temple oranges possess similar characteristics to the Tangelo. The Umatilla orange resulted from a cross between the sweet orange and the Satsuma orange. The Temple variety is believed to be the result of a natural hybrid between the tangerine and the grapefruit.

Improvement. Several problems arise in citrus improvement. As a rule, it takes from 6 to 10 years to fruit a seedling citrus tree unless the variety is top-worked on an older tree, in which case the time may be reduced to 3 to 5 years.

Another real problem is the occurrence of polyembryony (several embryos per seed), necessitating the production of many more hybrid seeds for desirable combinations.

Flowers are emasculated and pollinated much as described for the tree fruits previously discussed. Paper bags are used to protect the flowers and these may be replaced with cloth bags as described for the stone fruits.

The hybrid seeds are removed from the mature fruits, thoroughly washed, and planted at once in flats, as germination fails if they are permitted to dry in the air. When the seedlings are 6 to 18 months old, they are transferred to nursery rows, usually 6 by 12 feet apart. As soon as fruit is produced, records are taken as to type, quality, and disease resistance.

Objectives in Breeding. As the citrus fruits are grown for human consumption, improvement of quality becomes of great importance. A higher sugar content of oranges is especially desirable. A greater percentage of juice is an asset in all cases. The elimination of seeds makes a more satisfactory fruit.

Greater resistance to winter temperatures, especially late spring frosts, is the goal of all citrus-fruit breeders. The tendency to early flowering may result in the loss of the entire crop.

Diseases of the citrus fruits may be controlled best through breeding for resistant varieties. The success achieved to date leads to the belief that much more may be accomplished.

THE STRAWBERRY

The strawberry is a typical American plant native to our country. Our present varieties came from two species, the wild strawberry (*Fragaria virginica*) of eastern North America and the beach strawberry (*F. chiloensis*) found along the Pacific Coast.

Referring to strawberry improvement, we quote George M. Darrow, of the United States Department of Agriculture:

> "The work of the Department of Agriculture in strawberry breeding gives an excellent idea of the amount of detail involved in the production of improved varieties of plants. In Maryland, the Department fruited 86,000 strawberry seedlings, representing artificial crosses among 150 different varieties. Of these, 1,999 were selected for further testing, and only 7 have been finally regarded worth naming and introducing. In North Carolina, 54,000 seedlings have been grown and 1,245 selections have been made for further testing. In Oregon, the number of seedlings grown was 97,000 and the number selected for further testing is 1,331. In these few projects, then, more than a quarter of a million seedlings were involved; fewer than two out of a hundred were found to be worth further testing; and perhaps a score or fewer of new varieties will finally result. Of the few varieties already introduced, one is Blakemore, now regarded the best preserving strawberry in the United States; another is Redheart, now more extensively grown than any other canning variety; and two others are Dorsett and Fairfax, which are superior in dessert quality to other varieties previously grown. In addition to this breeding work, 30,000 wild Rocky Mountain strawberries were collected in 1936 to be grown at Cheyenne, Wyo., with the idea of incorporating their superior resistance to cold, dry winters into cultivated varieties."

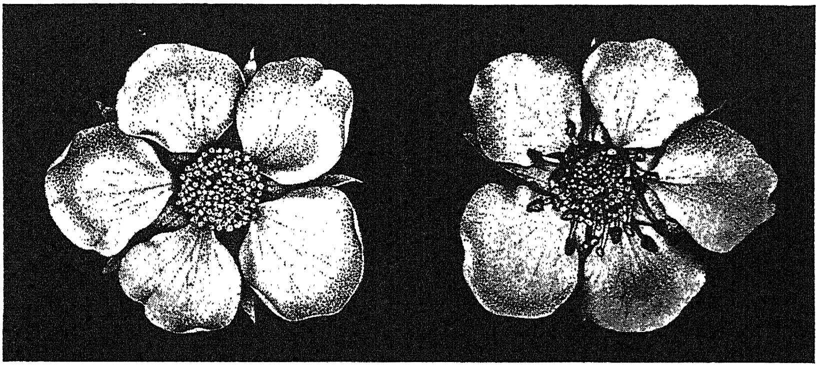


Figure 70. A perfect hermaphrodite strawberry flower and a pistillate flower.

Botany. Cultivated strawberries produce two types of flowers, the pistillate, or female, and the perfect, which, like the apple, carries both male and female organs. Insects produce cross pollination and varieties are likely to be of mixed genetic constitution. A variety which has pistillate flowers only can not set fruit unless perfect-flowered plants are near-by to provide pollen. For this reason the pistillate-flowered varieties are not generally as desirable as those having perfect flowers.

Technique of Breeding. Where facilities are available, the the use of a greenhouse makes it possible to provide for crossing with a minimum of work. In the field insects may interfere with the work and wire or cloth screens may be used to advantage.

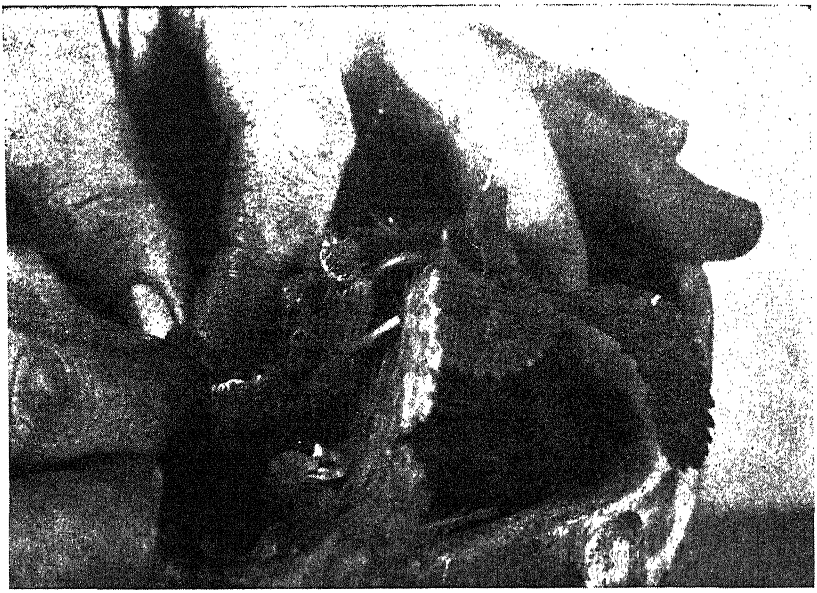


Figure 71. Crossing the strawberry. The petals, sepals, and stamens are removed by cutting them off with the thumbnail. The pollen of the variety to be used as a male parent is pressed against the pistil and the flower twirled between the fingers to brush the pollen on the pistil.

The flower is emasculated somewhat as described for the apple and peach by removing the stamens, corolla, and calyx at one operation.

Anthers are taken from the male parent. These may be held in the hand until the anthers burst open, then the pollen is applied to the pistil of the female flower either by hand or use of a small brush.

After crossing, the flower is marked and bagged. As soon as mature the hybrid berries are picked and the fruit is mashed in dry sand to separate the seed, then the mixture of seed, pulp, and sand is sowed in flats or pots at once. With temperatures of 60° to 80° F., the seeds will germinate shortly.

The seedlings are transplanted into flats about 2 inches apart. Within 2 to 4 weeks the young seedlings may be set in the field. If planted before the middle of the summer, the seedlings may produce fruit the following season.

Selections are made from the young plants on the basis of performance and the selected plants are placed in a separate trial plot for further selection and comparison with standard varieties.

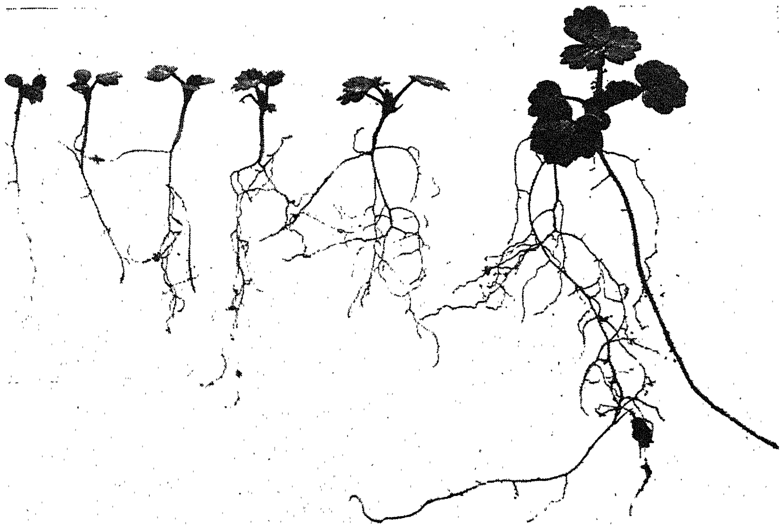


Figure 72. Strawberry plants grown from seed. The five seedlings at the left are the proper size for repotting; the one at the right is larger than the usual size.

Objectives. The principal objectives in strawberry breeding are: (1) improved dessert qualities of fruit, especially under adverse weather conditions; (2) greater resistance to diseases and insects attacking strawberries; (3) adaptation of varieties to regions of high temperatures and dry soil conditions; (4) suiting of varieties to market demands, such as better shipping qualities, and improved suitability for canning purposes. These and related problems offer opportunity for decided improvement by the breeder.

Suggestive Questions

1. How are the problems of improving fruits different from those of improving the grain plants?
2. What is a bud mutation?
3. Why can not one plant the seeds of apples to produce new varieties?
4. List the objectives of pear breeders.
5. What is meant by a self-sterile fruit?
6. What is polyembryony?
7. How do wild strawberries differ from the cultivated types?
8. What is meant by perfect flowers as in the strawberry?
9. Why are fruits important in the diet?

Suggestive Activities

1. Plant apple, plum, or peach seeds in the school garden or other available plot. When shoots are large enough, graft or bud with suitable varieties.
2. Prepare a list of fruits and varieties grown in your community. List the good and poor characteristics of each.
3. Make crosses of different varieties of fruit found in your community. Keep complete records of your operations.

CHAPTER XIII

THE IMPROVEMENT OF POTATOES

The so-called Irish potato, a new world vegetable, is eaten almost as universally in America as bread. In nearly every home it is a staple article of diet. Its great significance as a food plant should create interest in its improvement.

F. J. Stevenson, Senior Geneticist, United States Department of Agriculture, writes:

> "Millions of dollars are spent each year in providing ways and means of protecting the potato crops from diseases, and these colossal efforts have done their part in providing the consumer with potatoes fit for consumption; but, in spite of them, many millions of bushels are lost each year. The annual loss from late blight alone has averaged 9,000,000 bushels for the past ten years. Thus disease resistance has been a major objective in the well-co-ordinated national potato-breeding program now being conducted throughout the United States, in which the Department of Agriculture and all interested states closely cooperate. Already many varieties have been obtained that are resistant to late blight, to scab, and to two of the mosaic diseases. The results indicate that by using genetic principles as a working one, it should be possible to solve many if not all the disease problems of potato growers by combining resistance with superior qualities of economic importance, such as shallowness of eye, desirable shape, good cooking quality, high yield, and adaptability to local conditions."

BOTANY OF THE POTATO

The potato belongs to the genus *Solanum*, which also includes the tomato, pepper, and eggplant. There are known to be several species of the potato, but the cultivated varieties, as we know them, belong to the species *tuberosum*.

The potato is interesting in that it is reproduced by planting portions of the tuber. The tuber is essentially a storage organ, rich in carbohydrates, and, for this reason, the potato is an extremely valuable source of food.

Under favorable conditions the potato plant may produce flowers and seed borne in ball-like seed pods resembling miniature tomatoes, a characteristic which makes it possible to practice controlled breeding.

The potato flower is much like that of the apple. It contains both male and female organs, and, so, is considered a perfect flower. In those varieties whose pistil is the same length as the stamens, or shorter, the mature anthers may come in direct contact with the stigma and thus effect pollination. If the pistil is longer than the anthers, pollen may fall upon it when the flower drops, as at the end of the day. It is probable that insects, particularly honeybees and bumblebees, are responsible for more cross-pollination than is usually believed.

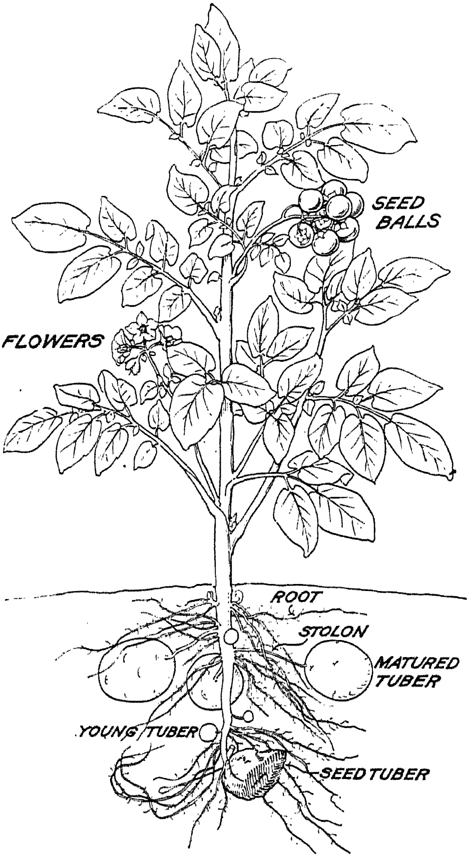


Figure 73. The potato plant and its parts.

TECHNIQUE OF BREEDING POTATOES

Most of the present varieties are the result of selecting plants grown from seed. A few varieties have come from mutations, but seedling varieties are far more important. In 1925, Clark estimated that of the 380 potato varieties originated in the United States, 306, 93.3 per cent, were of seedling origin and only 22, or 6.7 per cent, came from so-called sports, or mutants. The reader will note that this picture is far different from that given for the apple.

C. E. Goodrich, a New York clergyman, was responsible for the production of a variety known as Goodrich's Garnet Chili, a seedling from the imported Rough Purple Chili. Some of our best present varieties trace their origin to this seedling. Several of the better known commercial varieties are Beauty of Hebron, Burbank, Early Ohio, Early Rose, Green Mountain, Prolific, and Triumph.

The technique of cross-pollinating potatoes is much like that used with many other plants. Many varieties fail to produce viable pollen. The result is rather poor sets of hybrid seed. If the female plant produces viable pollen, the flowers must be emasculated by removing the stamens before they are mature. The anthers are usually removed before the pistil protrudes through the bud or a day or two before the flower opens. With a sharp-pointed forceps it is possible to remove the anthers quickly. The emasculated flowers are enclosed in a one-pound paper bag.

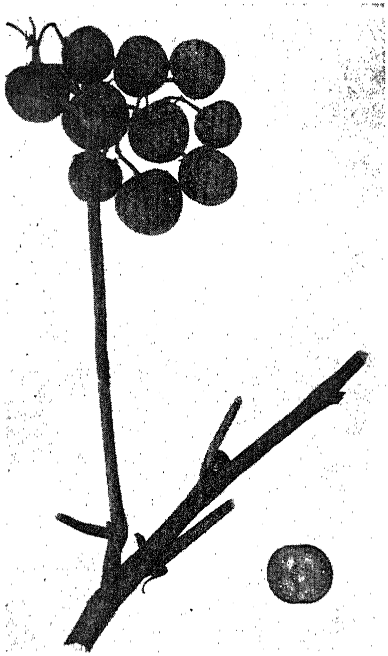


Figure 74. Potato seed balls, the result of natural pollination of a variety that produces fertile pollen.

Pollen is gathered from the male by removing anthers ready to open. These anthers are placed on the thumbnail and are gently tapped with the forceps. The pollen which comes out is collected on the thumbnail. Next, the pistil is carefully rubbed in the pollen on the nail. If desired, a small brush may be used to dust the pollen on the pistil. After pollination, the pollinated flower is placed in the paper bag for a week to ten days, when it may be replaced with a cheesecloth bag until maturity.

The seed balls are harvested and the seeds separated for planting in flats. As soon as the seedlings are established, they may be reset in the field to permit ample room for development and observation. The small tubers which develop are harvested for planting in the next generation. Careful selection as to character of tuber and plant is the next step in breeding. In a planned program particular attention is paid to disease resistance, as disease control is the principal problem in improvement.

Some breeders employ a system of self-fertilization as a means of improvement. Krantz, of Minnesota, has been a leader in this type of breeding. The plan is similar to that used in corn-breeding. The lines are selfed to secure pure lines and these pure lines are recombined to produce new varieties. Krantz, in describing his method, writes:

> "Selection in self-fertilized lines has been effective in establishing pollen fertility in combination with a wide variety of other characters. Used in combination with outcrossing it has facilitated the development of a large body of seed-setting material possessing selected germ plasm of the common varieties.
>
> "The results show that it will be possible through this method gradually to combine the best germ plasm in the potato into a useful form for breeding purposes. The difficulties involved are the absence of information on the best selection technique and the necessity of developing one suitable for effectively selecting and combining desired characters. Pollen sterility at the outset also presented a serious problem, since selection was restricted to the seed-setting individuals. The difficulties mentioned are associated with potato breeding in general and are not specific to any particular method. Information is gradually accumulating on methods and technique of selection in inbred lines. The difficulty of maintaining and continuing inbred lines has been greatly reduced through selection for high fertility.

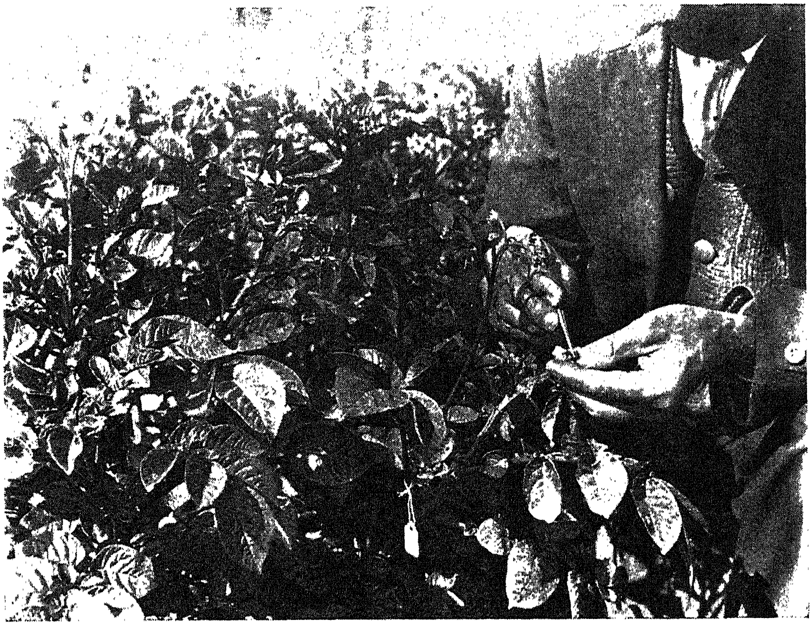


Figure 75. Pollinating potato flowers.

Comparisons have been made, and are in progress, of varietal crosses, single crosses, three-way crosses, and top crosses to determine the relative hybrid vigor that might be expected from the different types of combinations. The inbred lines are valuable for their concentration of desirable characters in combination with pollen fertility, early maturity, upright sturdy vines, resistance to certain virus diseases, fine cooking quality, and varying rest periods."

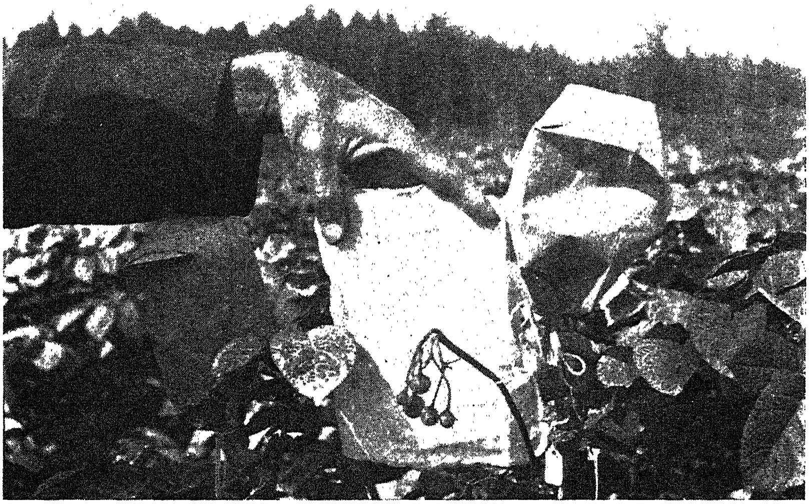


Figure 76. Seed balls as they appeared eight days after the pollination operation are shown in Figure 75. These fruits are the source of seeds from which new varieties are produced.

Many of the state agricultural experiment stations are co-operating with the United States Department of Agriculture in extensive potato-breeding programs. The work at Presque Isle, Maine, is typical of the principal work being done. Here the program involves the following: (1) the production of true seed to be tested in Maine and in co-operating states; (2) the distribution and testing of single-tuber selections obtained from various progenies; (3) the distribution of named and numbered seedlings to be tested in various locations; (4) conducting yield trials to compare new material with standard varieties; (5) testing new strains for resistance to the various potato diseases; (6) the making of detailed studies of the genetics of the breeding material; and (7) testing all varieties for suitability to market and consumer demands.

RESULTS OF BREEDING

While it is impossible to include all new varieties, a few of the more important will serve to illustrate the progress being made. Within a period of five years the United States Department of Agriculture and co-operating states distributed six new varieties. Warba and Red Warba were distributed by the Minnesota Agricultural Experiment Station. The other four varieties—Katahdin, Chippewa, Golden, and Houma, were distributed by the United States Department of Agriculture.

Warba is an early, high-yielding variety. The Red Warba originated as a bud-mutation from the Warba. It is characterized by its distinctive red color.

The four varieties distributed by the United States Department of Agriculture are all resistant to mild mosaic, a disease severely attacking Green Mountains in Maine.

Chippewa is a medium early, high-yielding variety that is adapted to a wide range of conditions.

Golden is a yellow-fleshed potato of good yielding ability and resistance to scab.

Houma, from a seedling grown at Houma, Louisiana, is adapted to the potato-growing sections of Louisiana, where it has produced good yields of high-quality tubers.

Katahdin has produced good yields under the unfavorable conditions of heat and drouth. The variety has been very promising in Michigan, where it is earlier than Rural and excels it in the percentage of marketable tubers. The smooth shape of the tuber and its shallow eyes make for little waste in cooking. Katahdin is resistant to the mild mosaic disease.

OBJECTIVES IN BREEDING

Several of the objectives in potato breeding have been indicated in the preceding paragraphs. To summarize these, the principal objectives are:

1. Breeding for earlier maturity. Early varieties are ready for the market sooner and thus command a better price. Such varieties are also likely to have more favorable conditions for growth.

2. Greater disease resistance, primarily to such diseases as early and late blight, scab, mild mosaic, latent mosaic, and other

virus diseases. The ultimate control of these diseases appears to lie in the development through breeding of varieties resistant to disease attacks.

3. Improved tuber quality with better shape, and shallow eyes, resulting in less waste. These are improvements of great importance to the consumer, who, after all, is the ultimate judge of the quality of the product.

Suggestive Questions

1. Is the potato an annual or a perennial?
2. Where is most of the potato-breeding work done?
3. What weakness is most evident in the potato varieties grown on your home farm?
4. Why is it easy to maintain a pure potato variety, once it has been developed?
5. List the major objectives in potato breeding.

Suggestive Activities

1. Make a collection of all varieties of potatoes found in your neighborhood. Visit your local grocer and get samples of varieties he may have for sale. Prepare a chart giving the characteristics of each variety. Indicate how breeding might be used in the improvement of each variety.
2. Harvest seed balls, dry carefully, and plant the seed. Record your observations.
3. Compare the flowers of the potato, tomato, eggplant, and pepper. List the genus and species of each.

CHAPTER XIV

IMPROVEMENT OF LIVESTOCK THROUGH BREEDING

The fundamentals that the modern breeder needs to know are the principles of genetics and the mechanics of reproduction. Mechanics includes formation of sex cells, fertilization, structure of the reproductive tract, and growth of the embryo.

PRINCIPLES OF GENETICS

Although it must be admitted that much progress has been made by breeders who have had no knowledge of the principles of genetics, one who is equipped with such knowledge is much better prepared to carry out an effective breeding program. The fundamental principles of inheritance in animals are the same as for plants and are treated in Chapter VII. No elaboration is, therefore, needed here more than merely to state that the inheritance factors are carried in genes in the chromosome and that some are dominant, others are recessive, and others are intermediate. Also, like in plants, most characters are complicated, being the result of the interaction of many genes.

Reasons for Poor Performance. The fact that many animals do not produce economically is so well known that no elaboration on that point is needed. There are two major reasons for the poor performance. One reason that has been discussed extensively in the previous books of this series is inadequate care and management, and the other is poor inheritance. To what extent each of these major causes is responsible for the lack of efficient production of livestock on farms can only be conjectured. Good inheritance is as essential as good care, if satisfactory results are to be obtained in the raising of livestock. No matter how good the inheritance may be, the results will be poor with poor care, and that, no matter how good the care may be, the results will be poor with poor inheritance.

Basis for Improvement. That many of our livestock do not have the proper inheritance for efficient production can be attributed in a large measure to a lack of understanding of the nature of inheritance and how improvement may be obtained. In order that one may be effectively equipped to improve livestock through breeding, it is essential that one first know the fundamentals of inheritance, the objectives one seeks, and the methods and means by which such objectives may be attained.

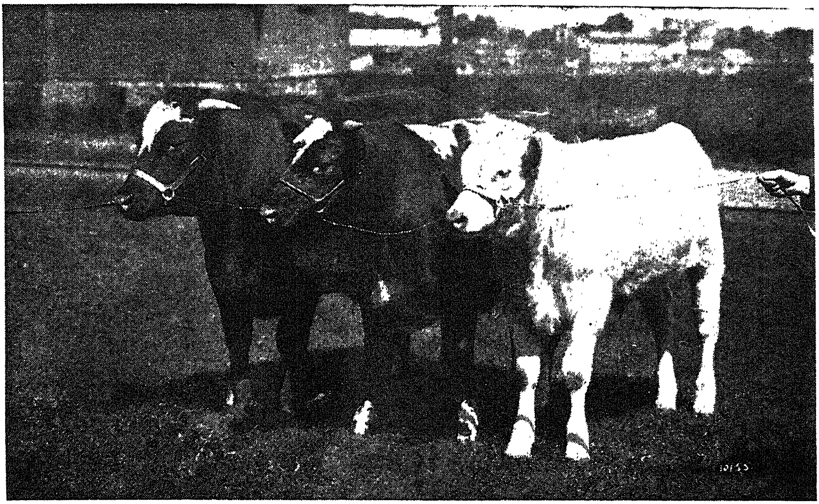


Figure 77. Good care brings satisfactory results only if the animals have the right inheritance.

ORGANS OF REPRODUCTION

While the basic principles of inheritance are the same for both plants and animals, the organs of reproduction are distinctly different. The reproductive organs of the male and the female are also altogether different.

The Reproductive Tract of the Male. Figure 78 shows the reproductive tract of the bull, which is typical for the males of other farm mammals. The system can be best followed by beginning with the *testes* and then following the course the *spermatozoa* take from that source. There are two testes held in a sack known as the *scrotum*. A testis consists of two parts—a testis proper and the *epididymis*. In the former the *spermatozoa* are formed, and the other, consisting of convoluted tubes, serves as the channel through which the sperm cells pass and also as a temporary storage place. From the epididymis there is a tube known as *vas deferens* which passes upward through the inguinal canal and then turns backward over the pelvic floor. Just after turning backward the vas deferens enlarges into what is known as an *ampulla* in which the sperm cells are also stored.

Just back of each ampulla a vas deferens enters the *urethra,* the opening running the length of the *penis* and serving as a passageway for both the urine and the *semen.*

Near the juncture of the vas deferens and the urethra are the prostate gland and the seminal vesicles. The seminal vesicles furnish secretions to form the semen. The semen consists of a mixture of the secretions of these glands and the spermatozoa.

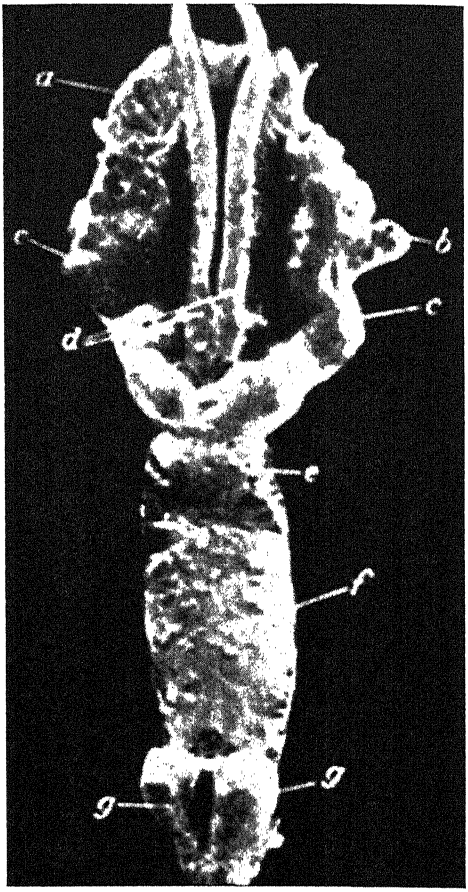


Figure 78. Dorsal view of the internal genital organs of a bull. A, bladder; B, ureter; C, seminal vesicles; D, ampullae; E, body of prostate; F, pelvic urethra; G, bulbo-urethral (Cowper's) glands.

The Reproductive Tract of the Female. Figure 79 shows the essential features of the reproduction tract of the cow, which is typical for the major features of other farm mammals. The tract can be studied most advantageously by beginning with the ovaries. There are two, located in the body cavity, one on each side just back of each kidney. It is in the ovary where the female cell *(ovum)* is produced.

The ovaries communicate with the *uterus* through tubes known as the Fallopian tubes through which the eggs must pass. The uterus consists of a body, two horns, and a neck, or *cervix.* The two horns (or *cornua*) extend forward and outward in a curving manner. The horns taper to a fine point as they are joined by the Fallopian tubes. The neck, or cervix, extends backward from the body into the *vagina.* It is through the opening in the neck of the uterus that the sperm cells must pass and also the fetus at parturition.

The *vagina* is a large chamber, opening to the exterior through the *vulva* into which the bladder also empties through the urethra.

REPRODUCTIVE PROCESSES

As with plants, in animals a union of male and female cells is essential for reproduction. Each of these cells has half the chromosome number of the body cells. Also, as in plants, we have female cells *(ova)* and male cells *(spermatozoa).* The ova are produced in the ovary of the female, and the spermatozoa, in the testes of the male.

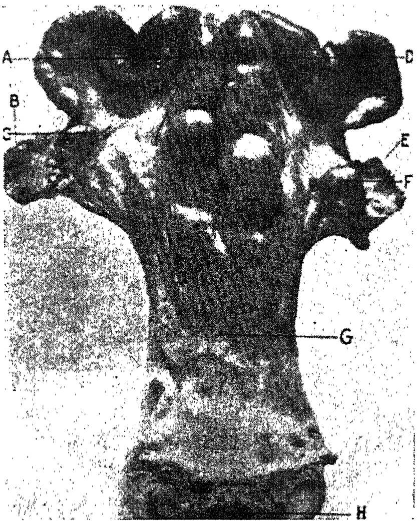


Figure 79. The essential reproductive organs of the cow.

Oogenesis. Oogenesis is the term applied to the formation of the egg, or ovum, in the ovary. In the very early development of the embryo, tissue cells are set aside for the formation of eggs. These early set-aside cells have the same chromosome number as the body cells which must be reduced to one half that number in the ripened egg. The process is illustrated in Figure 80, which shows that, first, the cells divide, producing daughter cells of the same chromosome number, but in later divisions the one of each pair of chromosomes is cast off in what is known as a polar body.

In most farm species eggs are formed in regular cycles unless the animal becomes pregnant, when the process is stopped until after parturition, when it is again resumed.

Spermatogenesis. The production of spermatozoa in the testes is known as spermatogenesis, a principle which is illus-

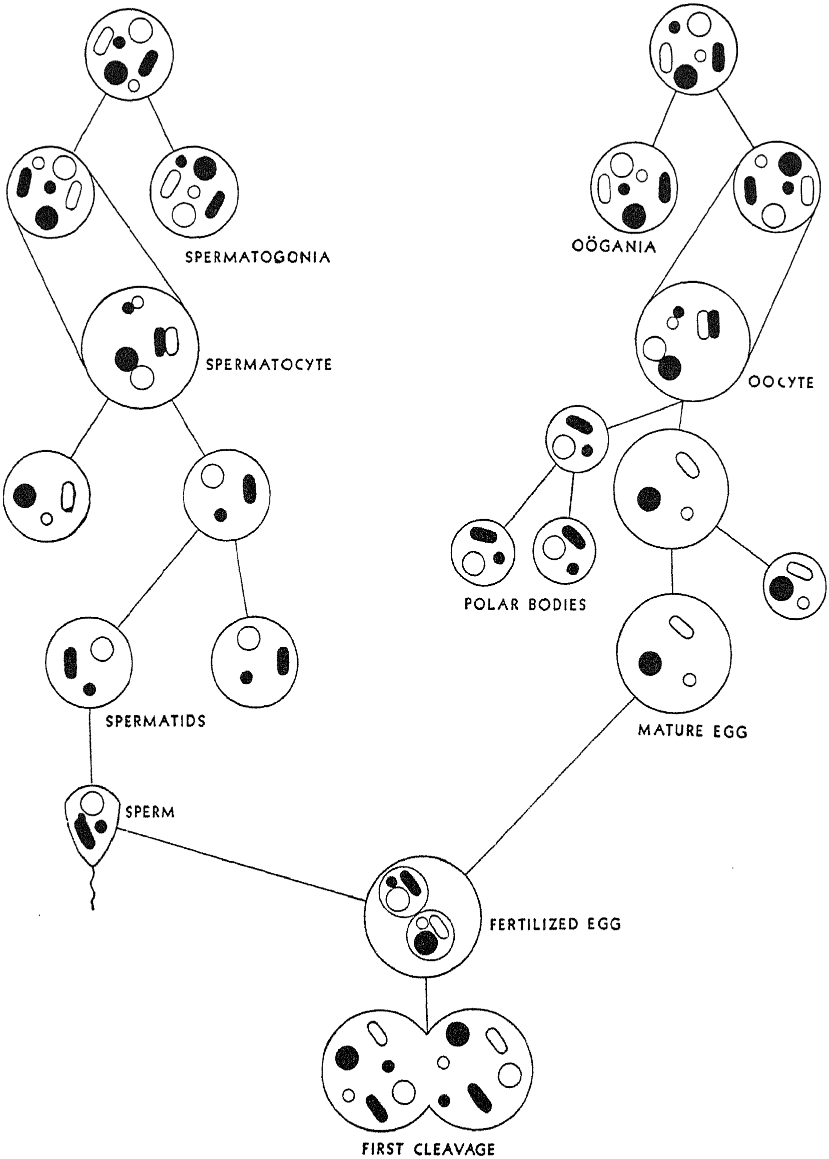


Figure 80. A schematic picture of spermatogenesis (left) and oogenesis (right), showing how the chromosome number of the original cells is reduced by one half to form the sperm and egg cells, respectively. Union of the sperm and egg cells, known as fertilization, is also shown.

trated in Figure 80. The spermatozoa carry but one half the chromosome number of the body cells, one of each pair going to a different spermatozoon. With the bull, stallion, and boar, spermatogenesis is a continuous process and tremendous numbers of sperm cells are produced. With some other species, of which sheep are an example, spermatogenesis is seasonal.

Fertilization. The union of the sperm cells with the ovum is known as fertilization. As a result of this union, one cell is now formed with all chromosomes paired. One of each pair comes from the male and the other one from the female parent. Thus each parent contributes equally to the offspring.

For fertilization to take place, the egg must have been secreted into the Fallopian tube and the sperm must have been deposited in the vagina or into the cervical canal. From there it travels through the uterus, its horns, and up a Fallopian tube.

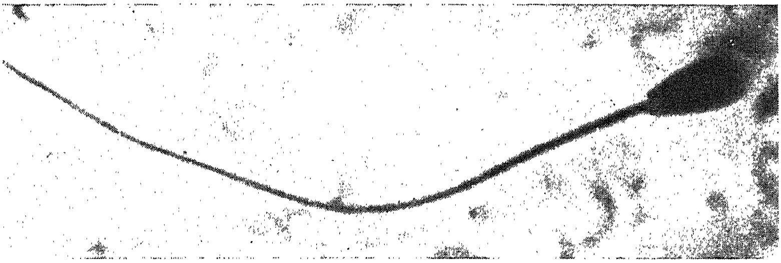


Figure 81. A bovine sperm cell; great magnification.

Ovulation. Since the ova are produced and secreted at cyclic intervals in the female, the time when fertilization is possible is related to that small part of the period when the ovum is released from the *follicle*, the cavity in the ovary where it is formed. The release of the ova is known as ovulation. In farm mammals ovulation is preceded or accompanied by a change of behavior which is known as *estrus*, or, more commonly, heat. Estrus is brought about by the increased secretion of a hormone known as estrogen. This hormone is secreted principally by the cells in the follicle of the ovary. When the follicle ruptures to discharge the ova into the Fallopian tubes, the estrogen secretion is diminished and another body known as the *corpus luteum*, or yellow body, starts to grow in the place of the follicle. This body secretes a hormone known as progestin and is necessary to maintain pregnancy. If pregnancy ensues, the corpus luteum remains until the end or near the end of gestation. If pregnancy does not follow ovulation, then the corpus luteum is resorbed and another follicle develops to produce another ovum. The time required for the complete cycle, together with the length of the gestation period, is as follows:

Species	Length of estrus Cycle days	Length of gestation Days
Cow	21	283
Horse	21	335
Sheep	17-28	148
Goat	21	150
Pig	21	114

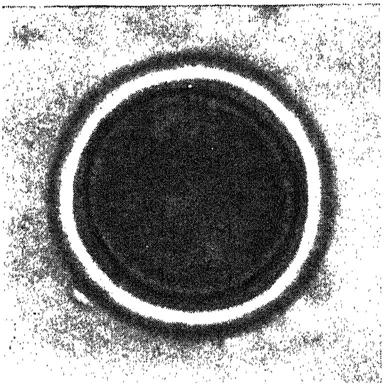


Figure 82. The ovum, or egg, from a cow. About 200 magnifications.

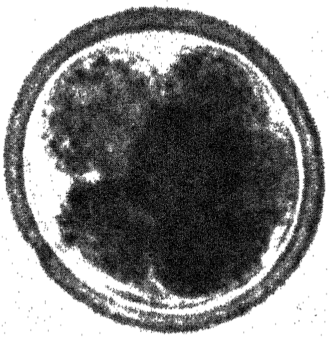


Figure 83. Cell division begins shortly after fertilization.

OBJECTIVES IN BREEDING

Before one can set up a workable breeding program one must know what one's objectives are. In general, the objectives fall into two broad categories—economical production and the desired form. Although the need for breeding livestock for more economical production is the more important, one must remember that it is also important to breed animals that are pleasing in appearance and action. The factors involved in economical production are many and varied and differ with the different classes of livestock. The more important of these factors are: capacity for production or work, breeding efficiency, vigor, resistance to disease, long life, size, and early maturity.

Capacity for Production or Work. The main objective in breeding farm animals should be efficiency to produce. With dairy cattle the product is milk and butterfat; with swine, it is pork; with beef cattle, it is meat; with sheep, it is mutton and wool; with poultry, eggs and meat; and with horses, work.

Breeding Efficiency. Since the production of all livestock or livestock products is dependent upon reproduction, it is obvious that breeding efficiency is a very important factor in efficient production. A beef cow that produces a calf every twelve months is twice as valuable as one that produces a calf every other year. For dairy cows it has been shown that the most milk is produced during the lifetime when a calf is produced every twelve months. Sheep that lamb regularly and produce two lambs each time are more valuable than those producing but one lamb. With swine, large litters are desirable.

Vigor. That vigor, or the ability to withstand adverse conditions, varies greatly with livestock is common knowledge. Frequently, lack of vigor manifests itself among the young, when, as a result, the losses will be high. Those lacking vigor and that still survive are set back whenever conditions are adverse. They frequently prove to be entirely unprofitable.

Resistance to Disease. The plant breeder has made great contributions in breeding plants that are resistant to diseases; but, as yet, very little progress has been made in breeding for resistance to disease in animals. There is, however, evidence that disease resistance may be inherited, and in the future the livestock breeder will be able to do for livestock what the plant breeder has done for plants in this field.

Long Life. Although a long life is not needed for swine and meat animals in general, for dairy cows and horses it is obvious that the capacity to produce or perform work over a long period is of great importance. A long reproductive life for beef cows and ewes is also desirable.

Size. Other things being equal, the larger animals within the breeds are desirable for dairy cattle, beef cattle, hogs, and sheep. For horses, it is essential that they be bred for the size most adapted for the work they are to perform.

Early Maturity. In all classes of livestock fast-growing, early-maturing individuals are much preferred to later-maturing individuals. It is obvious that the cost of raising an animal to the age when it comes into milk or is ready for the market is proportional to the time it takes to reach their productive period. Within all breeds and classes of livestock there is marked variability as to the earliness of maturity.

Breeding for Type. Many of the requirements for acceptable type in all classes of livestock are not associated with economical production. Yet to breed animals that conform to the standard set for any particular class or breed is a worthy object, as much satisfaction and pride are to be derived from possessing animals that appeal to the esthetic sense. For the breeder of purebreds it is absolutely essential that the animals conform to the standard in many particulars, else they can not be registered.

The first objective in a breeding program should, therefore, be to develop animals with the maximum capacity for profitable production and, in addition, obtain as much as possible of those characters that make for beauty.

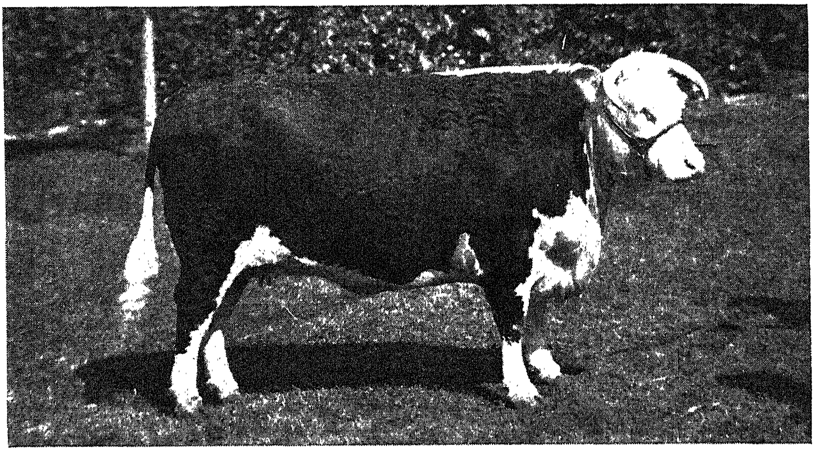


Figure 84. Good type as well as economical performance should be sought in a well-planned breeding program.

Suggestive Questions

1. Why must an animal have the right inheritance to be profitable?
2. Trace the path that spermatozoa must travel from the point of formation to ejaculation.
3. Where are the eggs formed and how do they get into the uterus?
4. What is meant by fertilization and where does it occur?
5. What happens in the ovary after it has been fertilized?
6. What are the chief objectives in breeding farm animals?

Suggestive Activities

1. Obtain a dead male animal and expose and identify all parts of the reproductive tract.
2. Obtain a dead female animal and expose and identify all parts of the reproductive tract.
3. Observe a herd or flock and ascertain in what particulars it is deficient in inheritance.

CHAPTER XV

DETERMINING WHAT AN ANIMAL WILL TRANSMIT

As with plants, one can not be certain from the appearance or performance of an animal what characteristics it will transmit to its offspring. Only where the characters are due to recessive genes will the animal transmit with certainty its own characteristics. As an example, the white spotting of the Holstein, Guernsey, and Ayrshire is due to recessive genes, and such animals can not transmit anything but the white spotting. Many of the desirable characters of farm animals, however, are due to dominant genes. An example is the black in the Holstein or Angus. Because a Holstein or Angus is black is no assurance that it will transmit only the black, because in both breeds there is also present a gene for red, and an animal carrying such a gene is as black as one carrying two black genes. From an inheritance standpoint, an Angus carrying one black and one red gene is only half black, while from appearance it is only black. The chances are even that it will transmit a black or red gene to its offspring. When two such animals are mated, one out of four offspring will, on an average, be red instead of black, one will be pure for black, and two will be like their parents.

The problem in breeding is, first, to ascertain the genetic make-up of the breeding animals and then proceed to mate them so as to produce offspring that are homozygous for the desired characters. To determine the presence of desirable or undesirable characters, it is first essential to have records of performance. The pedigree may be of value, but progeny performance from appropriate matings is the only certain means for proper genetic evaluation.

Record of Performance. By record of performance is meant the record of the achievement of an animal. For dairy cattle it is a record of the quantity of milk and butterfat produced by a cow during a given period. For poultry the record of performance is the number of eggs that a hen lays in one year, although it might also mean the gain in weight of a bird in a given time. For swine the customary record of performance is the weight of a litter of pigs when six months of age. The most common record of performance of a beef animal includes the rate of gain and market value of the animal. For sheep a record of performance includes the same factors as those listed for beef cattle and, in addition, a record of the number of lambs and the quantity and the quality of the wool.

In addition to these records, there must also be listed the record of performance in the shows for all classes of livestock, and for dairy cattle the class in Herd Classification.

Use of Records. Although records of performance are absolutely essential in order to formulate a sound breeding program, they are generally misused. In the main, breeding animals have been selected on the basis of their own attainments as far as the desirable characters are concerned. As examples: dairy cows are retained for breeding purposes on the basis of the quantity of milk and butterfat they produce; or a herd sire is selected on the basis of the record of his dam; breeding hens selected on the basis of the number of eggs they produced in a year; and, so, examples may be cited for each class of livestock.

A good record of performance is an indication that only such an animal has the necessary factors to produce well. It does not furnish good evidence or proof of what such an animal will transmit to its offspring. It is possible that for every good factor a high-producing animal has, it has also a poor factor, and then the chances are even that either one will be transmitted to the offspring. A good example is that of a Holstein that carries a factor for red. In appearance it is no different from one that is pure for the black factor; but, from a genetic viewpoint, such an animal is only half black and one half of its offspring can be expected to receive the red factor. Factors for production characters, although much more complex, behave similarly.

There are two ways of ascertaining whether or not a Holstein carries a red factor. One is to mate it to red animals, when, on an average, one half of the offspring will be red instead of black, if the red factor is present, and none will be red, if such an animal is pure for the black factor, because black is dominant to red. This method is known as the progeny test. The other method is that of ascertaining that the parents are pure for the black factor which necessitates a study of the ancestry for evidence of the presence of the red factor. If none of the ancestors has ever shown any evidence for red, then it is certain that the factor is not present. If, however, red is found in some of the ancestors, one can not be certain, without progeny testing, that it is present in any individual that is black and white.

Progeny Testing. It is only through the performance of the progeny that one can evaluate the genetic make-up of animals. It then follows in a sound breeding program for all classes of livestock, that animals must be selected on the basis of an analysis of the performance of the progeny.

Selection of breeding stock on the basis of progeny performance has been developed to its greatest extent in dairy cattle. Since the principles involved are the same for all classes of livestock, a consideration of the method of analyzing progeny performance for dairy cattle will illustrate the problem for all farm animals.

In evaluating the genetic make-up of an animal on the basis of progeny performance there are six important considerations. These are: the number of progeny, the level of the production records, comparative records of progeny and dam, the uniformity of the records, inclusion of all offspring, and the conditions under which the records were made.

Number of Progeny. As there is a great deal of variability in all livestock and as it is possible that through a fortunate combination of factors a desirable offspring may result from the mating of two inferior parents, it is obvious that many progeny are needed for a proper evaluation of the parents. Since the average cow, during her lifetime, has but five offspring of which only half are females, one can seldom get enough daughters from a cow to evaluate her properly. For the bull, however, it is possible to have an adequate number of offspring. For dairy bulls it has been agreed that six daughter-dam pairs with records are the minimum for proper evaluation. It would be well, however, to have the records of more than six daughters.

Levels of Production Records. It is obvious that it is desirable to have the largest possible production records on the progeny. Animals with high records, however, are relatively few in number, and one must, therefore, decide upon the lowest production that will be acceptable.

Daughter-Dam Comparison. Not only should there be a high level of production, but the daughters should be better producers than their dams, unless the dams have unusually high-production records. The most convenient method for making daughter-dam comparisons is by means of the so-called arrow chart illustrated in Figure 85. In this chart the record of the dam is indicated by a dot and the record of the daughter by the head of an arrow leading from the dot. When the dam's records are plotted in an ascending order, one can at a glance tell how the daughter's records fall in relation to the level of the dam's record.

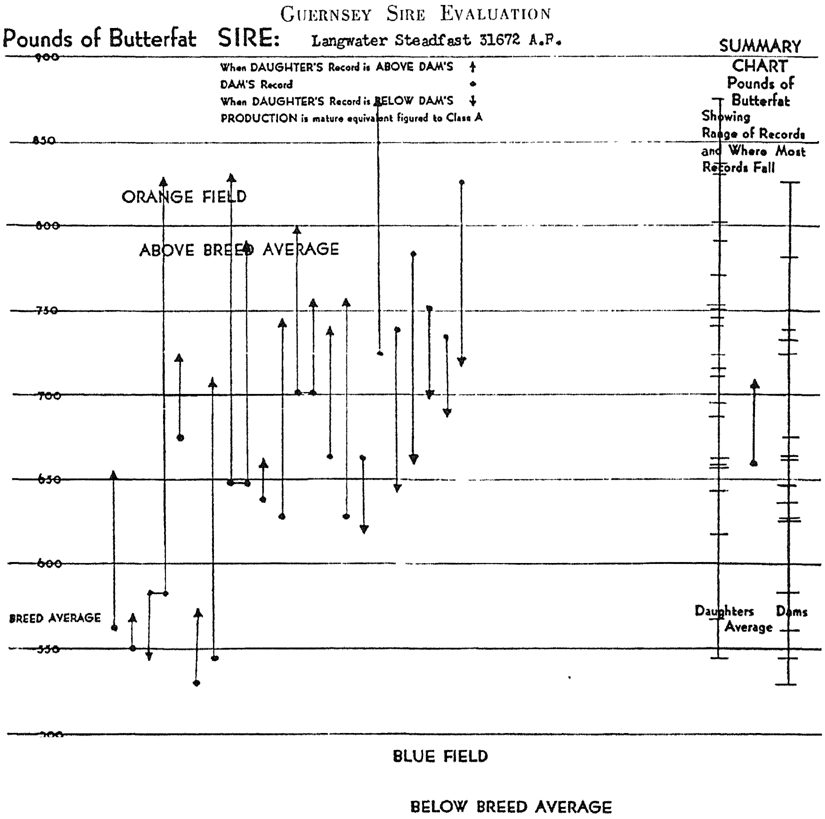


Figure 85. The arrow chart is a convenient form to use in comparing production of daughters (point of arrow) with that of their dams (head of arrow). By Ohio State University.

Uniformity of Records. It is not only important that the daughters have a high average production record but that the records be uniform. Great variation in the records of production must be taken as evidence that the parents have a mixed inheritance.

All Progeny Must Be Tested. Frequently only the best daughters have been selected for testing and, as a result, an inferior transmitting bull has had what appeared to be a very creditable record. In considering any breeding animal it is essential that all progeny have been tested or that those tested are unselected.

Conditions Under Which Records Are Made. To evaluate records according to the conditions under which they are made is most difficult but must be taken into consideration. Tables have been made to convert records to a standard on the basis of the number of times a cow is milked daily and for the length of time she carried a calf, but there is no reliable method by which one may accurately evaluate the feed and the management which are very important factors. Good judgment must prevail in determining the influence of environment on the records.

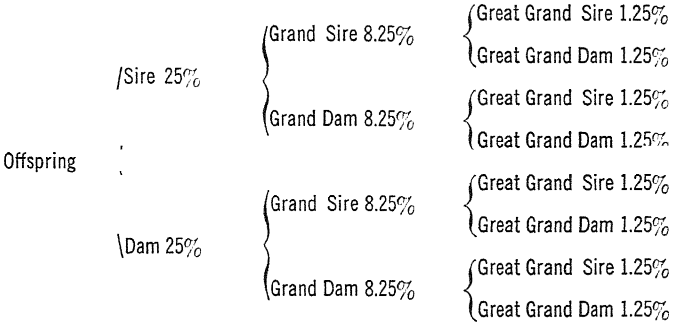


Figure 86. The average probable inheritance from each member of each of the first three parental generations. It is obvious that little reliance should be placed upon the performance of grandparents as affecting the inheritance of an animal.

Value of a Pedigree. By pedigree is meant merely an extended record of the ancestry. For dairy cattle and, to some extent in other classes of livestock, it is customary to add information such as production and showring records of the individuals. To the extent that such records are complete will the pedigree have worth in evaluating an animal. If the records of all females and all the progeny of both males and females are given in the pedigree, it may be the basis for a fair evaluation of the genetic make-up of the animal.

If all animals have offspring with uniformly high records, such records may be taken as reasonably good evidence of uniform high production and of the likelihood that this character will be transmitted to the offspring.

One must, however, beware of most pedigrees, as too often only the best records and the best offspring are reported. In evaluating pedigrees one must also be on guard for "fill-in" when an animal has no record or progeny with records. Pedigree writers have developed a scheme for filling in spaces left vacant for lack of facts. When no records are available, they use a phrase such as "by a brother to the sire of" and list the daughters of a distant relative and their records.

In using pedigrees for evaluating animals one should be aware that, theoretically, at least, all ancestors have contributed to the inheritance of any animal. Of this total inheritance the two parents contribute 50% or 25% each. The four grandparents contribute 25% or 8.25% each. The eight great grandparents, 12½% or about 1.5% each and, so, the importance of each individual decreases with the distance of the generation.

The Bull Index. The bull index is a device which endeavors to give production transmitting levels of a bull. Several different formulas have been proposed of which one known as the equal parent index is commonly used. Both fat percentage and milk production may be calculated. In order to determine an index for a bull, a number of daughters (preferably more than 5) and their dams must have production records. The index for either fat percentage or quantity of milk is ascertained from the following formula:

Bull's index = dams' average + 2 (daughters' average — dams' average) are on an average intermediate between the two parents. If the daughters of a bull produce more than their dams, it is assumed that the bull's inheritance is equal to the dams' plus twice the difference of the dams and their daughters. If the daughters produce less than their dams, then twice the difference is subtracted from the dams' records to arrive at the index.

Record of the Dam. The dam's actual performance record is not a good index of her genetic make-up, as has been demonstrated many times, particularly with dairy cattle. Very often dairy bulls out of cows with high production records have proven to be disappointments. Of greater importance is the performance of the daughters or the sons of a cow.

Performance Within a Family. It has been emphasized that selection of a breeding animal upon the basis of the performance of that individual is not sound. It has long been known that individuals tend to vary from their parents toward the mean of the group, or the family. This variation can be interpreted to mean that the inheritance within a good family does not vary greatly. The differences of performance of individuals within a family is mostly due to rather small differences in inheritance. One can, therefore, expect any individual within a family to transmit about the average of that family.

The Proven Sire. In any class of livestock a sire is said to be "proven" when a number of his offspring may be compared with their dams. For the dairy breeds, a bull is called proven when six of his daughters and their dams have production records.

The term "proven sire," therefore, does not imply that such a bull is desirable, for he may be proven to be inferior. Records show that less than half of the "proven" dairy bulls increase production.

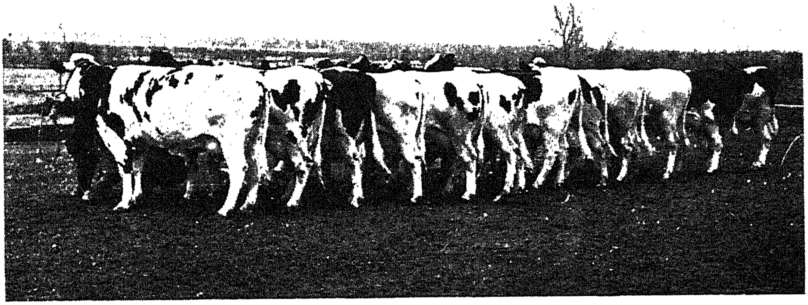


Figure 87. Only through the performance of the offspring can one ascertain the worth of a sire. These are all daughters of one bull.

Since the sire can become the parent of many times the number of offspring that the female can, it is obvious that livestock improvement can best be accomplished by the use of superior sires. Only after a bull is proven can one be certain of his transmitting ability. It, therefore, again becomes obvious that only through extensive use of good proven sires can one expect a rapid and consistent improvement of all classes of livestock.

Selecting the Young Bull. Not all can use only proven sires and young sires must be tried before they can be proven. Wise selection of young males to become sires is a very important and, at the same time, difficult job. For dairy cattle it has been shown that bulls sired by good proven sires and from cows sired by good proven bulls proved nearly always to be desirable. The next best method is to use bulls sired by good proven bulls and out of cows from a good family. Bulls selected merely on the basis of the records of their dams often proved disappointing.

For other classes of livestock the same principles maintain, although it is more difficult to obtain the necessary information. One can, however, often observe the offspring from the sires of prospective young sires and formulate an idea of their desirability. Picking a young ram, beef bull, or boar on the behavior of his sisters and brothers is far better than to select him on the appearance of his sire or dam.

Suggestive Questions

1. Why does an animal not necessarily transmit its own characteristics?
2. What is meant by record of performance?
3. What is the only certain method of ascertaining what an animal will transmit?
4. What is meant by progeny testing?
5. Why is it necessary to have a considerable number of offspring to evaluate a parent?
6. Why is uniformity among the offspring desirable?
7. What is a pedigree? Of what value is it?
8. What is meant by a bull index?
9. Of what value is a record of performance of the dam?
10. Why is it important to consider all members of a family?
11. What is a proven sire?
12. What are the important points to consider in the selection of a young sire?

Suggestive Activities

1. Study the offspring of a sire and note variations in color, type, and performance.
2. Obtain a sales catalogue and select the best and poorest pedigree on the basis of the information given, with the reasons for the selection.
3. From the records of a dairy herd, determine the equal parent index for a bull.
4. Obtain all the information available on a herd sire and critically evaluate him.

CHAPTER XVI

SYSTEMS OF BREEDING

Systems of breeding are generally classified according to the degree of the relationship of the animals mated. Every breeder should be able to recognize these systems and know how to use them. The systems of breeding are: inbreeding, line breeding, outcrossing and crossbreeding. In addition, "grading up," although not a system of breeding but a method of improving cattle, should be added to this list.

While a sound breeding program should be based upon the use of individuals selected for their ability to transmit the desired characteristics rather than adherence to any system of breeding, a knowledge of what can be accomplished by the use of the different systems of breeding may be a great aid to breeders. There are occasions when inbreeding should be practiced, while at other times the objective can best be attained by outcrossing.

INBREEDING

Inbreeding is the term applied to breeding where closely related animals are mated. The mating of sire and daughter, sons and dam, sister and brother, and first cousins would be classed as inbreeding as that term is generally understood. In another sense any common ancestor, to both the sire and dam, no matter how distant, shows inbreeding. In this latter sense there is more or less inbreeding in all animals.

Measure of Inbreeding. The degree of inbreeding of any animals may be determined by applying a formula to the extended pedigree. One such formula is:

$$F_x = [\,(\tfrac{1}{2})^{N + N' + 1} \text{ X } (1 + F_a)\,]$$

In this formula F_x represents the coefficient of inbreeding. N represents the number of generations from the sire and N′ the number of generations from the dam to the common ancestor.

F_a is the coefficient of inbreeding of the common ancestor. The method of calculating the coefficient of inbreeding for two generations of brother-sister mating is in Figure 88. The complete pedigree is given on the left, while, on the right, the common ancestors for each generation are given. The arrows indicate the number of independent chains through which the sire and dam are connected. There are two chains S T D and S E D in which $n + 1 + n' = 3$. There are 4 chains S T U E D, S T F E D, S E U T D, and S E F T D in which $n + n' + 1 = 5$. Consequently the coefficient of inbreeding for two generations of full brother and sister mating $= 2\,(\frac{1}{2})^3 + 4(\frac{1}{2})^5$ or 37.5%.

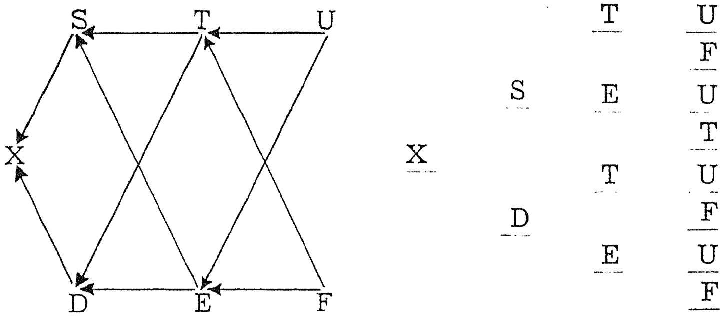


Figure 88. Illustrating the method of calculating the coefficient of inbreeding for two generations of brother-sister mating.

Use for Inbreeding. Inbreeding in skilled hands may serve two purposes—either to discover any undesirable recessive factors and enable one to get rid of them, or to concentrate and conserve some very desirable characters.

By inbreeding animals tend to become more homozygous for desirable as well as for undesirable characters. It may, therefore, be practical to locate the individuals that have the least undesirable recessive factors, such as lethals or factors for the lack of vigor. Animals that are decidedly lacking in such characters are then not used. Another specific use is to locate Holsteins that carry the red factor.

The greater use of inbreeding, however, comes in perpetuating and concentrating desirable characters in superior stock. When inbreeding is used for this purpose, rigorous selection must also be practiced. Inbreeding is also frequently indicated when an unusually good sire is available. Rather than dispose of such a sire, it is frequently advisable, when his daughters become of breeding age, to mate him with them.

Dangers of Inbreeding. Experience has shown that the inbreeding of all classes of livestock has many pitfalls. In most cases one may expect loss in vigor, size, and fertility.

LINE BREEDING

Although line breeding is inbreeding, it differs from the more generally accepted concept of inbreeding in that the common ancestor is more distant and in that it has for its purpose the concentration of the inheritance of one animal. It is largely through line breeding that families are established and the animal which is the basis of the line breeding becomes the foundation animal of the family or subfamily.

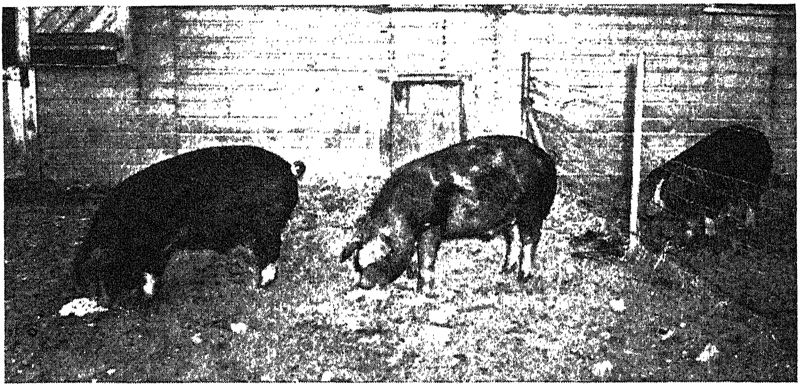


Figure 89. Crossbred swine often possess peculiar color patterns as compared to the purebreds but have proven to be superior in other respects.

Results of Line Breeding. Line breeding tends toward greater uniformity, especially when selection for characters of the animal is practiced.

Limitations of Line Breeding. Since line breeding has for its objective the concentration of the inheritance of one great animal, it can be practiced for but a comparatively short time. With succeeding generations the concentration of the inheritance of the individual which is the basis of the line breeding becomes diluted.

Families become established as the result of line breeding and the animal to which the line breeding is directed becomes the foundation of the family.

OUTCROSSING

Outcrossing is the term applied to matings within a breed of nonrelated or very distantly related animals. Using a sire from one family on females of another family is outcrossing. The main objective of outcrossing is to bring in factors that are not now in the herd or flock.

Results of Outcrossing. Intelligent use of outcrossing in breeding can cause rapid improvement in two ways. First, by careful selection animals with the largest number of desirable genetic factors can be mated with superior offspring as the result. By the theory of "nicking" this phenomenon should occur in outcrossing to the maximum extent possible within a breed.

Undesirable Effects of Outcrossing. Outcrossing tends to do the opposite of line breeding and inbreeding in that outcrossed animals become more heterozygous. Consequently, outcrossed herds and flocks tend to be less uniform than when inbreeding is practiced.

CROSSBREEDING

Crossbreeding applies to the mating of animals of two distant breeds. Crossing of breeds is practiced in all classes of livestock. There are many reasons for crossbreeding. It may be because crossbreeds are superior animals or to change from one breed to another. In the dairy it may be an effort either to produce better beef or to alter the fat content of the milk. In horses it may be used to produce animals better suited to special conditions.

Superior Market Animals from Crossbreeding. Sheep and swine producers resort to crossbreeding as a regular procedure in the production of market classes. The sheep breeders of England and sheepmen of the western plains have long resorted to crossbreeding, believing that the crossbreeds are more vigorous and better grazers and feeders than their purer parents.

More recently, experiments have shown that crossbreeding in swine increases the size of litters and that the pigs produced are more vigorous and gain more rapidly.

Changing Breeds by Crossbreeding. It often happens that a livestock producer desires to change from one breed to another. He may do so by disposing of all members of the breed he may have or by keeping the females and using a sire of the breed desired. The latter method will require more time, but it is often more expedient. The second generation cross will be three quarters the newly chosen breed, and, by careful selection, may have nearly all the breed's characteristics.

Crossbreeding Dairy Cattle. Dairymen resort to crossbreeding under several different conditions. They may want to change to another breed in which case a number of years will be required before a herd can be obtained with the majority of the characteristics of the new breed. When better beef calves are desired, dairymen have long resorted to the use of beef bulls on dairy cows. As market demands for milks of different fat contents have developed, it has often been deemed advantageous to crossbreed in order to produce milk of the desired fat content. Where Holsteins were kept and higher fat-content milk was desired, Jersey or Guernsey bulls were used for crossbreeding. If the market is more favorable for low-testing milk, Holstein bulls may be used on Guernsey and Jersey cows.

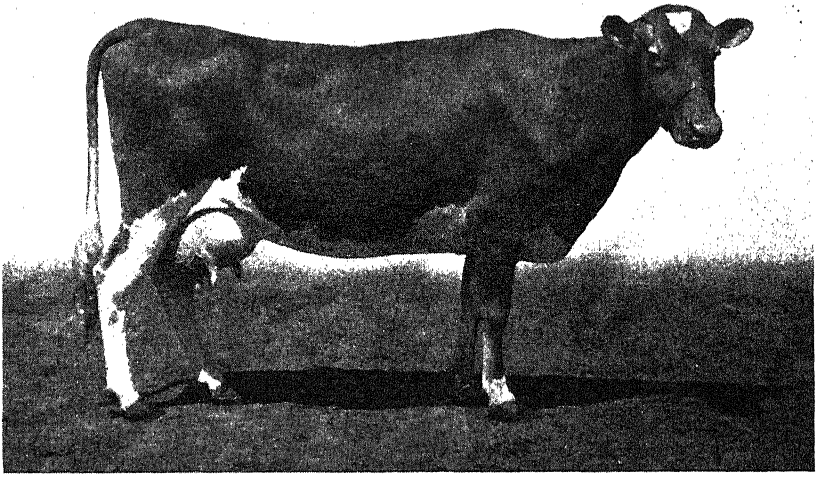


Figure 90. This grade Guernsey cow is a descendant of a "scrub" great granddam. As a result of using good purebred Guernsey bulls for three generations, all scrub characters have disappeared.

Crossbreeding Horses. Horses have long been crossbred partly in the desire to produce horses that were more suited to certain conditions and partly because stallions of the desired breed were not available. In many localities crossbreeding of draft types and light horses is practiced to produce an intermediate type for general work purposes.

GRADING UP

The most significant achievement in breeding is the grading up of herds and flocks by the successive use of purebred sires of the same breed. Often the grading-up process began with scrub or nondescript stock. Assuming that the foundation females have none of the characteristics of the breed to which the purebred sire belongs, the first generation will be 50 per cent of that breed. For the second cross this figure will be 75 per cent; the third 87½ per cent, and so on. Each successive cross will approach 100% by one half of the previous increment.

Many grade herds developed in this way have all the characteristics of the purebred as far as can be seen, but they can not be registered.

In grading up, the greatest improvement is noted in the first cross. Assuming that equally good sires are used, only one half the improvement can be expected for additional cross that was observed in the previous one.

Methods Used by the Old Breeders. Great improvement was obtained by breeders of all classes of livestock before the science of genetics was discovered. Although these early breeders knew nothing about the fundamental basis of inheritance, they used methods that now have proved to be fairly sound in the light of new knowledge. They emphasized, first of all, selection of the breeding animals that met their standards. Next they mated animals of the types desired with the belief that "like begets like." This adage we now know is only partially true, as an animal may be of quite different genetic make-up than its appearance indicates.

The Breeder of Today. The modern breeder has the advantage over the old breeders in that the science of genetics gives him a sounder concept of the problem, and then systems that were not available until recently have been developed for the evaluating of animals. Another important advantage over the older breeders is that there is a much larger number of animals of superior quality from which to select.

Improvement of all classes of livestock could be sped up greatly if only the breeders would avail themselves of the knowledge on sound breeding practices now obtainable and adopt some of the several forms of testing. Testing for performance is the cornerstone of any sound breeding program. Without it, intelligent selection of breeding stock can not be made.

Suggestive Questions

1. What is meant by inbreeding?
2. Under what conditions is it advisable to inbreed?
3. How does linebreeding differ from inbreeding?
4. What is meant by outcrossing? What are the advantages?
5. What is meant by crossbreeding?
6. What is meant by "grading up"?
7. Under what conditions is crossbreeding advisable?
8. What methods did the old breeders use?

Suggestive Activities

1. Obtain pedigrees of animals and ascertain the system of breeding they represent.
2. From the pedigree of an inbred animal calculate the per cent of inbreeding.
3. Observe a herd of crossbred swine. Compare the crossbreds with the purebreds for color, type, vigor, and any other factor.

CHAPTER XVII

BREEDING PUREBRED LIVESTOCK

To become a breeder of purebred livestock is a worthy aspiration and represents the highest type of agriculture. To be a successful breeder requires an understanding of problems and objectives of the business as well as certain personal qualifications that are not so essential in the breeding of grades.

Importance of Purebreds. Although purebreds comprise but a very small percentage of the population of any breed or class of livestock, they have been the basis for livestock improvement. It is true that in each breed many grades excel many purebreds, but the best purebreds are superior to the best grades. For dairy cattle, where best comparative data are available, purebreds average approximately 25 pounds more fat per year than grades.

Rather than criticizing purebreds for not having excelled grades more than they have, a fairer attitude would be to commend them for the attainment of the grades. The reason for this attitude is that grades are the results of the use of purebred sires. An honest evaluation of the contribution of purebreds to the livestock industry, therefore, must include all grades as well as the purebreds.

Opportunities in Breeding Purebreds. For those who are qualified, the breeding of purebred livestock offers an opportunity to make a lasting contribution to agriculture and a chance to make more money than can be made from the breeding of grades.

Livestock Improvement. It should be stated that, on the whole, improvement of grades has been more rapid than of purebreds until it has become evident that some grades are approaching the best purebreds in performance. The challenge to the breeder of purebreds is, therefore, greater than ever before, if purebreds are to continue superior to grades. That purebreds can be improved to stay well in the vanguard is maintained by all students of animal breeding. Scattered among its individuals, each breed contains plenty of superior genes, which, if they could be brought together, would produce most superior individuals. With the information at hand, all that is needed is that the breeder shall be equipped with the knowledge, the desire, and the ability to do the job.

Increased Income. From the monetary standpoint, breeding good purebred livestock of any kind offers splendid opportunities. Superior stock is usually recognized and commands high prices that make their breeding a profitable adventure.

Desirable Associations. There is a third factor that makes the breeding of purebred cattle desirable. Helpful associations may be formed. The breeders of purebred livestock of any breed are closely united in their particular breed associations. Among their members are found the leading names of great men. It is noteworthy that many of the outstanding men in all walks of life breed purebred livestock.

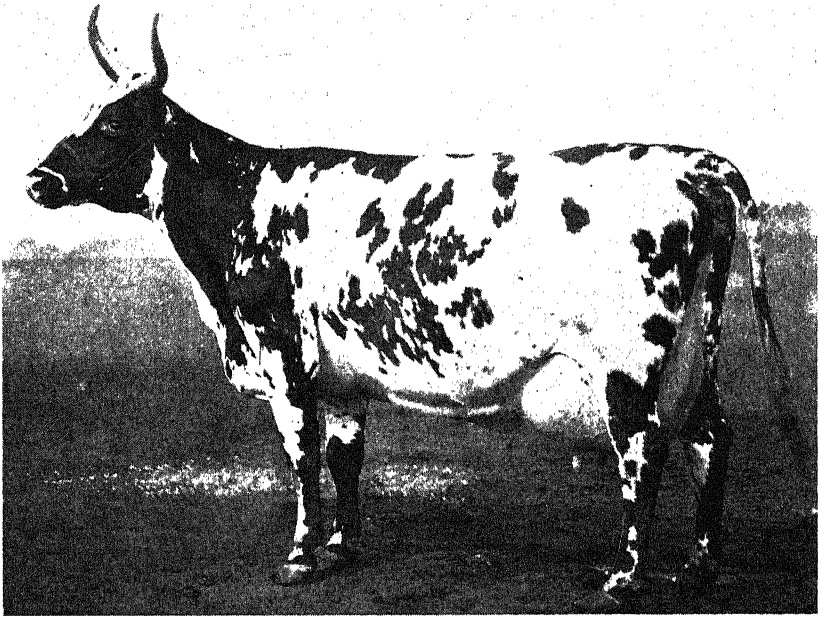


Figure 91. Breeding for beauty of form offers a challenge that adds interest.

Qualifications of a Breeder. To be a successful breeder of pure livestock a man must possess all the characteristics essential for production of commercial stock and several additional qualifications. He must study breeding, be an idealist to a certain extent, and must have more business ability than is ordinarily required for commercial livestock production. He must know the basic laws of inheritance in order to plan proper matings. He must also study the animals individually and know the pedigree of each one. The offspring of each mating must also be carefully studied and compared with the parents, that he may note whether or not there has been any improvement. Every detail has importance.

He must be honest and have a good reputation. The purebred business is based on the honesty and integrity of the breeders; for they report the animals for registration, and, unless their representation is honestly made, pedigrees have little value. The buying public is quick to sense dishonesty, so that a man with a poor reputation suffers because there will soon be no demand for his stock.

WHAT ONE MUST DO TO BECOME A SUCCESSFUL BREEDER OF PUREBREDS

Many breeders of purebred livestock fail to become successful because they neglect or fail to give the necessary attention to several important phases of the business. Among these neglected phases are record-keeping, prompt registration of animals, prompt transfer of animals in case of sale, and the conducting of proper tests.

Keep Records. The first requirement is that careful and accurate records must be kept of every animal. Records are desirable for grades but must be kept for purebreds. These records include names of sire and dam, date of breeding, date of birth, and a description of the animal or whatever marking for identification may be required by the breed association.

Registration. Another important "must" is the prompt and accurate reporting of animals for registration. Upon receipt of the registration certificates, it is important that they be checked with the animals for any error and then that they be filed so as to be easily accessible.

In circumstances where the records of performance systems are available, it is imperative that all animals be "tested." Sound breeding programs can not be formulated without such records.

Transfer. When registered animals are sold, it is important that a transfer record be applied for immediately and that all papers be forwarded promptly to the new owner. Delay or neglect in this particular causes uneasiness and suspicion on the part of the buyer. As a result, chances for a resale to this individual are lost, and a bad reputation can easily be established.

SELLING PUREBREDS

For commercial classes of livestock there are well-established markets to which animals are consigned with reasonable assurance that they will bring reasonable market values. For purebreds no such markets are available. There are two methods by which purebreds may be sold. One is by private treaty and the other by auction.

Private Selling. In selling privately it is essential that the breeder first decide what price he will demand and then seek a buyer. The setting of a fair price is rather difficult, as values of purebreds differ greatly, depending on the popularity of the lines of breeding and records of performance. Frequently sales are made upon a bargaining basis in which the seller asks one price and the buyer makes a lower offer. A final selling price is determined by compromise.

Selling at Auction. Many purebreds are sold at auction of which there are two kinds—consignment and private auctions. On consignment, a number of breeders supply one or more animals for the sale; the private auction is one where only one breeder sells his own cattle. Not infrequently large breeders dispose of all their surplus stock through private auctions.

The chief function of the auction is to establish values for purebred animals. On this basis all breeders are served by auction sales whether or not they consign animals for sale. From the prices that animals of similar merit bring the breeder is in a better position to set fair values on his salable animals.

ADVERTISING PUREBREDS

Since there are no well-established markets aside from auctions to which a breeder may consign his surplus stock, it is left to him to find buyers. He must then make known to the public the kind of stock he has for sale. The following are some of the most important methods of getting a herd before the public:

1. Paid advertisements in breed and general farm journals.
2. Notes in breed journals on achievements of animals, good production records, and showring winnings.

3. Act as host to farm meetings whenever there is opportunity.
4. Show animals at local and other shows.
5. Attend breed meetings to extend circle of one's acquaintances.
6. Maintain a neat farmstead with a road sign giving the name of the farm and the kind of stock promoted.
7. Perform public service of any kind to get a breeder's name before the public.

SERVICES A BREEDER SHOULD RENDER

The breeder of purebred livestock, on account of his knowledge and experience, is in position to render a valuable service to others.

Furnish Sires. From the broader view one may say that the chief purpose served by breeders of purebred livestock is to furnish sires for the maintenance or improvement of the ordinary run of livestock. The breeder, therefore, should not consider his job done when he sells an animal for breeding purposes but should offer additional services to his clientele.

Professional Skill. He should be looked upon as a professional person whose knowledge and skill have gone into the animal that he breeds, so that part of the purchase price of the purebred animal may be regarded as payment for his extra ability. The breeder should not end his service here. He is fitted to give advice on what sires to use and out of what females breeding stock should be selected.

GETTING STARTED WITH PUREBREDS

It is obvious that one may buy either a whole purebred herd or flock or may gradually change from grade stock to purebreds. Each way has its advantages. When one buys a complete purebred herd or flock, one is well established at the start, whereas, when one starts with a few purebred animals, it may take a long time to develop an entire herd or flock of purebreds.

By starting with a few and gradually changing from grades to purebreds less capital outlay is needed, one gradually gains experience as the purebreds increase in numbers, and, lastly, a herd or flock is developed from the same foundation stock.

What number of purebreds is necessary for a satisfactory beginning is a real problem. With swine, one sow is adequate, on account of the short reproductive cycle and the large number of young in a litter. With sheep, two or three ewes are usually adequate. With cattle, however, more stock is necessary because of the slow rate of reproduction. A minimum of three breeding females is needed to assure enough female offspring.

Suggestive Questions

1. Why are purebreds essential for livestock improvement?
2. What opportunities does breeding of purebreds offer?
3. What qualifications must one possess to become a successful breeder of purebreds?
4. What are the more important things that a breeder of purebred livestock must do that are not required of a breeder of grades?
5. How are purebred breeding stock sold?
6. In what ways may a breeder advertise his stock?
7. What services should a breeder render?
8. How may one get started in the purebred business?

Suggestive Activities

1. Observe some herds or flocks where good purebred sires have been used on common females. Note the improvement that is made.
2. Attend an auction sale of purebreds.
3. Prepare advertising copy for a purebred male of each class of livestock.
4. Obtain the necessary blanks from the breed association and fill in application for registry and transfer.

CHAPTER XVIII

KNOWN INHERITED CHARACTERS

Although very little is known about the nature of the inheritance of production factors for any of our classes of farm livestock, there is evidence that they are inherited. Considerable is known about the inheritance of minor characters, some of which are of practical importance, while others are of only academic interest. Of those of academic interest, sex and color inheritance and the inheritance of lethal factors are the best known.

SEX

As economical livestock production is based on high reproductive efficiency, inheritance of this character is of great importance. Much is now known about the inheritance of sex, twinning, multiple births, and fertility.

Mammals. In mammals the males produce two types of sperm, one which produces a female and the other a male, when they unite with the egg. The male mammal is, therefore, a heterozygote and the female is a homozygote.

For cattle and swine there are slightly more males than females, while, for the horse and sheep, there are more females than males. In the United States during the years 1916 to 1939, inclusive, there were born about 5% fewer female than male children.

Several attempts to influence the sex ratios of males and females in offspring have been made by treatment of the female genital tract or by selection of breeding animals that were observed to produce more of one sex than of the other. So far, all these attempts have resulted in failure.

Poultry. In poultry the very reverse is true, that is, the male is homozygous and the female is heterozygous. More females than males are hatched.

BIRTHS

Twinning. The tendency of cattle, sheep, and horses to produce twins is an inherited character the exact nature of which is unknown.

In dairy cattle twinning is undesirable, because one half of the twins are mixed male and female, when 90% of such females, known as freemartins, are sterile. Damage done to the cow in producing twins is greater than any gain that may come from the increased number of calves.

For horses also twins are undesirable, for most of the twins do not survive.

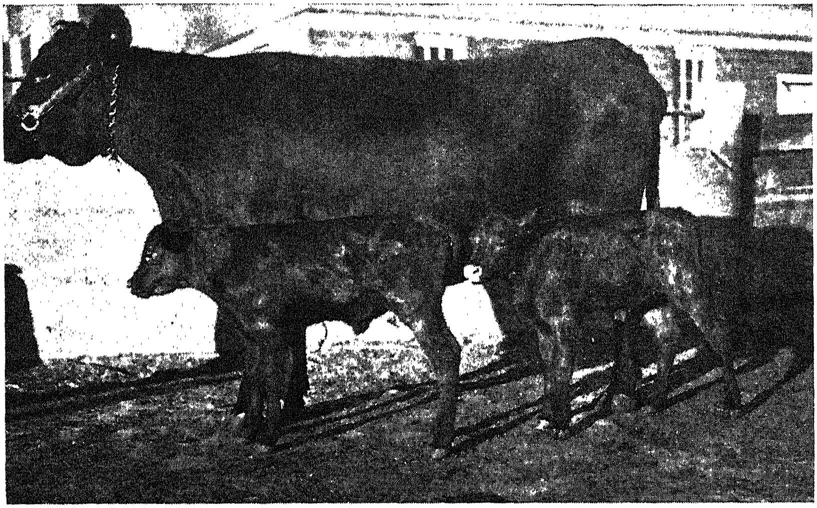


Figure 92. Twinning is an inherited character.

In cattle and horses it is desirable to select stock that do not have an inheritance for twinning.

For sheep, however, twins are desirable. By careful selection a strain may be developed to produce a high percentage of twins.

Multiple Birth. With swine, large litters are normal and desirable, and with them, as with sheep, strains that will produce large litters may be developed by selection.

FERTILITY

Reproduction is basic to livestock production. Lack of fertility may be caused by numerous factors, such as disease and nutrition; but inheritance is also important. The best evidence for the part that inheritance plays in fertility comes from the many experiments with inbreeding, when the most serious results have been sterile offspring. In all classes of farm animals it is important to select breeding stock that is known to have a good fertility record. The nature of the inheritance of fertility is not known, but it is undoubtedly complex.

COLOR AND PATTERN IN CATTLE

A great deal is known about the inheritance of color in cattle, of which only a small portion of the more important facts can be given here. Color inheritance is important, for many of the breeds have special color requirements.

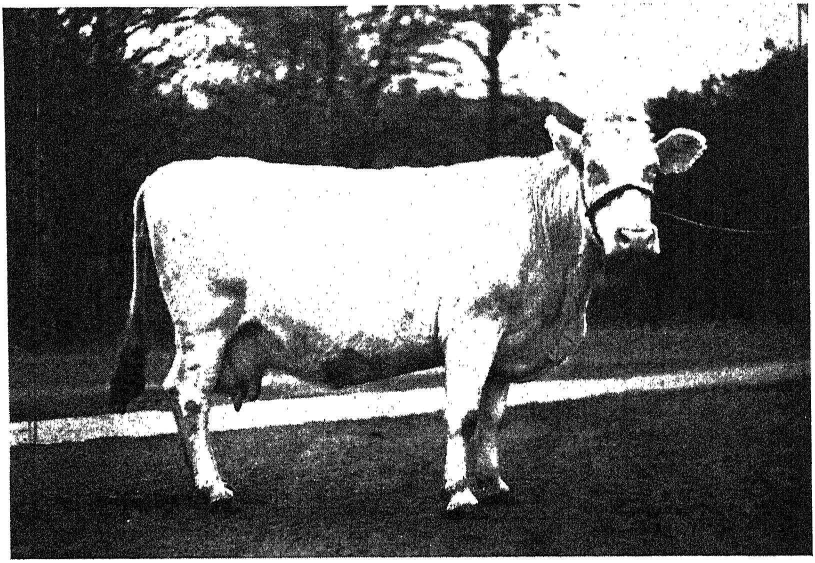


Figure 93. An albino cow. Her parents were normally colored but each carried a factor for albinism.

Cattle are not only colored but they have color patterns each of which may be modified by a number of factors. The color of cattle varies from the jet black of the Holstein, Angus, and Galloway, to an almost complete absence of pigment in light-colored Jerseys or in pure albinos. Albinism, which is a freakish or accidental occurrence, is an entire lack of color pigment, so that the animal is pure white. It may occur in all species of animals.

When the color extends over the entire body, the animal is said to be solid-colored, as in the Angus, Galloway, Red Polled, and some Jerseys.

In general, the darker colors are dominant to lighter shades, although there are exceptions. The red of the Red Poll is dominant to the yellow of the Guernsey, and the black of the Angus is dominant to the red of any breed.

Recessive White Spotting. Color patterns vary widely and are modified by many factors. Some color patterns, such as the white spotting of the Holstein, Guernsey, Ayrshire, Jersey, and Shorthorn, are recessive. In the recessive white spotting, the darker color is dominant to the lighter, as, in a cross between the Holstein and the Guernsey, the offspring will be spotted but black. The amount of color is determined by some modifying factors which will account for three general variations in the relative amounts of pigmented and white areas. By selection for these factors it is possible to breed Holsteins that will be mostly white or mostly black. Among the Holsteins some animals have a dominant factor for white heads. Animals carrying such a factor have white heads with small black spots about the eyes.

The recessive white spotting factor causes white legs or at least pigment does not extend from the hoofs to the knees. Another factor present in the Shorthorn, Jersey, and Ayrshire, and known as the pigmented-leg factor, causes the legs to be pigmented. Holsteins with pigmented legs can not be registered, as that condition is considered as evidence of a cross with Jersey, Shorthorn, or Ayrshire.

Another interesting factor that has caused concern is the pigmented skin factor. This factor is present in all recessive white-spotted breeds, but is not present in many Guernseys. It causes skin spots on any part of the body and may also cause the nose to be partly or wholly pigmented. Many breeders of Guernseys dislike pigmented noses and wonder how the mating of clear-nosed Guernseys produced pigmented noses on some of the offspring. The factor is dominant and may manifest itself on the body without affecting the nose.

Dominant Color Patterns. Among the dominant color patterns are the Hereford, Dutch Belted, color-sided, and Wild Park cattle. Probably the best known of the dominant color patterns is the Hereford pattern which is characterized by a white face, white over the neck and shoulders, and varying amounts over the back. The feet and underline are also white. This pattern is dominant, as, when Herefords are crossed on any other breed except the Wild Park cattle, the offspring will have the Hereford pattern.

The Dutch Belted pattern is characterized by a white belt of varying widths around the body. This pattern is also dominant, behaving like the Hereford pattern. In matings of Hereford and Dutch Belted cattle the offspring are black with both the Hereford and Dutch Belted patterns.

The color-sided pattern is characterized by varying amounts of white along both the top and the undersides. This pattern is also dominant. The color-sided pattern is not found in any breeds in this country.

The Wild Park cattle are not found in this country, but mention is made of them on account of their interesting color pattern. To the casual observer they appear to be solid white, but close inspection reveals black hairs on the ear tips and around the muzzle to produce a pattern. This pattern is dominant to all other patterns.

Roans and Brindles. Other important patterns are brindle and roan patterns, and spotting patterns that affect the legs and skin of several breeds. Roan is a condition where pigmented hair is interspersed with white hair. If the pigment is red, it is known as a red roan. If the pigmented hairs are black, it is known as a blue roan. The red roans are common and desirable in the Shorthorn breed, where they result from the mating of Reds to Whites. All matings of reds and whites, however, do not produce roans, which fact is explained on the basis that another factor known as a roan modifier must be present. Roans do not breed true. On the average, such matings produce two roans to one red and one white.

Brindle is a condition where narrow stripes of black hair are arranged on a red background. It is found in crossbreds. It requires the presence of two factors for expression. One of these is the black-spotting factor found in many Jerseys, and the other is a brindling factor found in the Angus. As the Jerseys do not have the brindling factor, they are never brindled. The Angus, of course, are not brindled, because they are solid black and do not have the black-spotting factor.

COLOR INHERITANCE IN SWINE

In swine the solid white is dominant to all other common color markings such as black, red, and gray. Black and gray are usually dominant to red. Red and sandy colors are due to fairly complex inheritance factors and varying results may be obtained by crossing these colors with blacks.

The white belt of the Hampshire is dominant to other color patterns.

COLOR INHERITANCE IN SHEEP

Sheep have less color variation than any other class of livestock. The white or gray body color is usually dominant to the black. The karakul is an exception, as in this breed the black is due to a dominant black factor. The curl of the karakul is also dominant to the straight wool of other breeds.

The faces of sheep may be white, black, or spotted. The white face is incompletely dominant to the black face. Crosses of black-faced and white-faced sheep produce spotted-face offspring.

COLOR INHERITANCE IN HORSES

Color inheritance in horses is also very complex and only some of the more commonly-known facts pertaining thereto can be related here. The intensity of color varies from pure white in albinos to a deep black. As in cattle, horses also have color patterns some of which are dominant and others recessive.

The nature of color inheritance in the horse is different from that of cattle. In cattle the darker color is always dominant to a lighter color which fact is not always true in the horse. From a genetic viewpoint, there are four different kinds of brown horses. One, when mated with black, brown, or chestnut, produces only brown. Another, when mated in the same way, produces brown and chestnut offspring, and a third type produces browns and blacks, while a fourth type produces brown, black, and chestnut offspring. It is also possible to get black offspring from brown parents. Pure black horses breed true; but, as indicated, some browns contain factors which dilute the black to brown or chestnut.

An albino mated to an albino produces an albino; but, in contrast to cattle, the albino factor in horses is not completely recessive. Brown and albino crosses produce buckskin, while chestnut and albino matings produce yellow, to indicate that the albino factor has a lightening effect upon color genes.

Roan and gray colors of horses are due to a different color inheritance mechanism than roaning is in cattle. In horses there is a dominant factor for gray and roan. It is of interest to note that many gray horses develop tumors in old age, the inherited susceptibility for which is associated with the gray factor.

There are two types of piebald inheritance in horses. One is recessive, like the recessive white spotting in cattle, and the other is dominant.

HORNS

Horns are present in both cattle and sheep. In both these classes horns may also be absent. The inheritance of horns or hornlessness is somewhat different in these species.

Cattle. There are several factors involved in the inheritance of horns in cattle. The most common one is where hornlessness is completely dominant to the horned condition, such as in the Red Polled. Here all offspring from crosses of Red Polled and horned breeds are polled, but each carries one factor for horns. Some breeds, however, carry factors for scurs and others carry special factors for horns, so that in such crosses either scurs or horns will result.

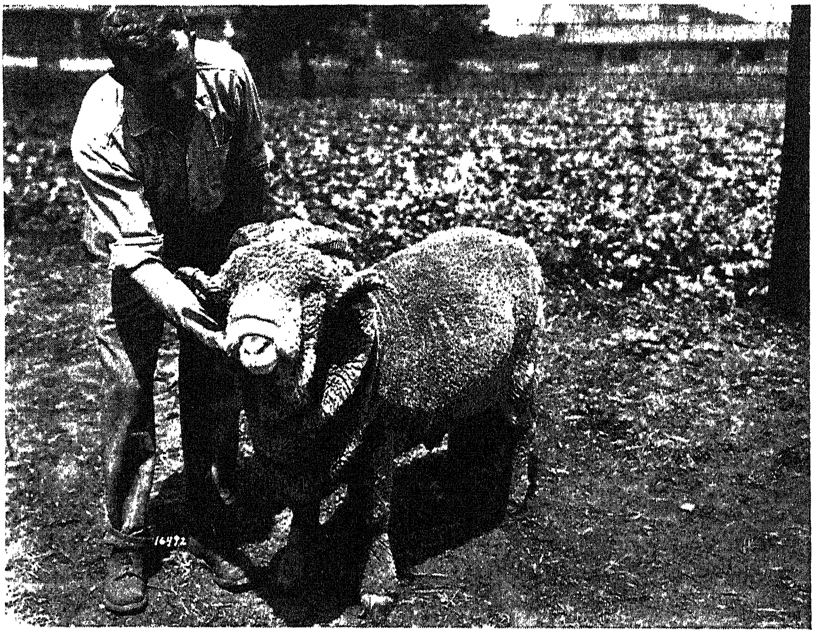


Figure 94. All male Rambouillets are horned and all females are hornless.

Sheep. Only two types of horn inheritance in sheep will be given. In the Rambouillet breed all males are horned and all females are hornless, while in the Dorset Horns, both sexes are horned. In crosses of the Rambouillet and Dorset Horns, both sexes are horned. In the male the horned condition is dominant to the polled condition, while in the female the reverse is true. In the females another factor known as "horn modifier" must be present, if horns appear. The horn modifier is present in the Dorset Horns, but not in the Rambouillets.

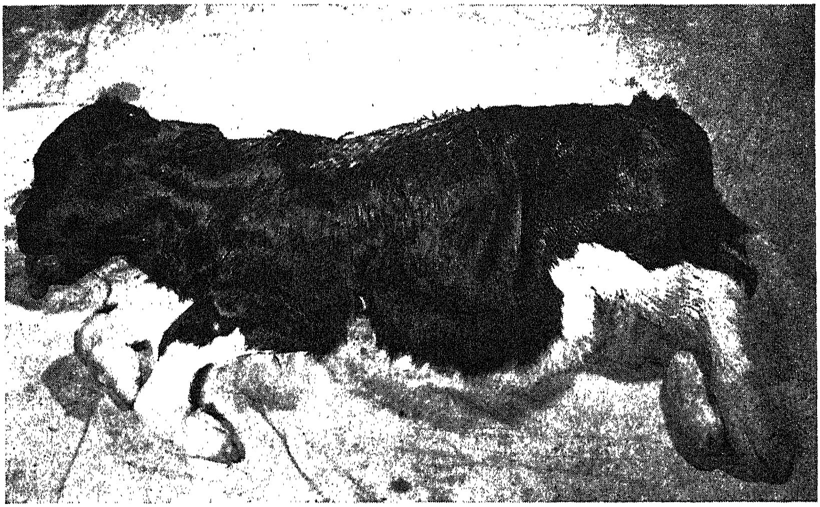


Figure 95. A "bulldog" type of lethal causes death of calves at or shortly after birth. Both parents carry this factor.

INHERITED LETHAL CHARACTERS

Lethals are characters that cause death either in the uterus or shortly after the animal is born. These characters are present in all classes of animals and present a real problem to the breeder. As lethals are recessive, an animal may carry the factor without any visible signs of its presence. The only method by which lethals can be detected is through proper matings. Crosses of two parents carrying lethals will, out of each four offspring, result in an average of one dead, two carrying the lethal factor, and one free from it.

Cattle. There are more known lethals in cattle than in any other species. Among the better known are: the bulldog head, amputated leg, short spine, agnathia, epithelial defect, hairlessness, and impacted molars.

The bulldog-head lethal is a condition where the head of the calf is greatly enlarged and is shaped somewhat like the head of a bulldog.

The amputated-leg lethal expresses itself by the absence of the lower part of the legs.

In the short-spine lethal the neck and spine are greatly shortened, caused by the absence or fusion of a number of the vertebrae.

In agnathia all or most of the lower jaw is absent.

In the epithelial-defect lethal the skin below the knees is missing, as is the mucous membrane lining the mouth, nostrils, and tongue.

The hairless lethal manifests itself by a complete absence of hair at birth. Such an instance must not be confused with premature births where hair is normally absent.

The impacted-molar lethal manifests itself by impaction of the molar teeth.

Swine. Although there may be many lethals in swine, only a few are known. Those most commonly known are paralysis of the hind legs and *atresia ani* (closed rectum). Scrotal and umbilical hernia, while not lethals, cause heavy losses in swine and are inherited.

Sheep. Relatively few lethals are known in sheep, although many may be present. Only one lethal is fairly common, being found wherever sheep are raised. This lethal is known as the short-legged character.

Horses. Two characteristics which have been regarded as semi-lethal or sublethal by some workers are bleeding and roaring. These conditions are results of the inheritance of abnormal vascular membranes and respiratory organs. Some abnormal skeletal characteristics have also been noted, but their mode of inheritance is somewhat uncertain.

INHERITANCE OF PRODUCTIVE FACTORS

The inheritance of production factors in all classes of livestock is very complicated and little is known about the exact nature of the factors. All evidence, however, points to the fact that all desirable characteristics have a hereditary basis. The following desirable production characters are common to all classes of livestock: vigor and vitality, capacity for feed, size, early maturity, good type, and resistance to disease. Other special characters will be considered separately for each class of stock.

Vigor and Vitality. Profitable livestock production demands animals that are vigorous and possess vitality, so that they may withstand the adverse conditions to which they are often subjected. The factors that contribute to vigor and vitality are many, and even the most vigorous animals carry some factors for low vigor. Most factors for low vigor are recessive in nature, as evidenced in inbreeding experiments where usually the inbred animals have low vitality.

Capacity for Feed. The importance of good capacities to utilize feed is obvious, as basically animals serve to convert feed into livestock products. In all classes of livestock there are individuals that possess all the desired characteristics but the adequate ability to utilize feed, and, as a result, they are not economical. This character is inherited, as proved by the fact that by selective breeding a greater capacity for feed may be established. This character, too, is due to many factors.

Inheritance of Size. Other things being equal, with the possible exception of horses, the larger animal is more profitable. The ultimate size an animal will attain is definitely limited by inheritance. The hereditary factors involved are many and complicated and no single factor is yet known.

In all breeds and classes of livestock are found evidences of attainment in breeding for size. In practically every breed there are herds, families, or strains that exceed the average of the breed in size.

Early Maturity. The desirability of early maturity is obvious. This character is definitely hereditary and also due to many factors. As a rule, there is a negative correlation between early maturity and large size. The reason is not that early maturity factors act antagonistically to factors for large size, but rather that, with other things equal, it takes longer for the large animal to attain its mature size. In selecting for early maturity alone one also selects for smaller size, unless extreme care is exercised in selection.

Type. Type, as it is usually understood, involves all the visible body parts, and one would expect it to be the result of a most complex inheritance. Most of the breeding operations have been with a certain type as its objective. Because of the complexity of the inheritance, it is the most difficult to attain by breeding. "Typey" parents do not necessarily produce "typey" offspring, yet this fact does not imply that inheritance is not a most important factor. Analysis of showring winners in many breeds has revealed that prize winners tend to run in families.

Resistance to Disease. In plants, breeding for resistance to disease has been of great practical importance. While it has been shown that strains of mice may be developed that are resistant to certain diseases to which mice, as a whole, are very susceptible, there is, as yet, no evidence that heredity plays a part in resistance to disease among farm livestock.

PRODUCTIVE ANIMAL CHARACTERS

Productive Milk Characters. The inheritance of milk and butterfat production has been the subject of more investigation than any other characteristics of livestock, and yet there is very little known about its exact nature. From the more recent work it is apparent that a number of different sets of factors are responsible. One group of factors has to do with the inheritance of the maximum milk production, another group of factors has to do with persistency, and a third group of factors is responsible for the butterfat production. Further research is expected to break down these groups of factors still further.

For a long time some persons have believed in milk signs, that is, that some body characteristic is a sign of a high-producing cow. Among these so-called "milk signs" that have been shown to have no correlation with milk or butterfat production are: shapes of the escutcheon, a long slender tail, wide spacing between the ribs, fine silky hair, thin skin, prominent hook bones, and others. The best correlation was found to be between large udders and well-developed veins and milk production.

Productive Beef Characters. That a large number of factors are involved in the inheritance of beef characteristics is certain. That some of the factors are dominant and others recessive is indicated by experimental work when beef and dairy types were crossed. In these experiments it was observed that the front quarters of the crossbreds resembled more the beef than the dairy parent. The middle and hind quarters resembled more the dairy parent than the beef parent.

Productive Swine Characters. Although swine are usually classified into two groups, the lard type and the bacon type, the characters for production apply equally well to both types. The characters usually considered in swine production are rate of gain, economy of gain, size of litter, and proportion of lean to fat. The inheritance of trends toward certain types has been established, but usually several genetic factor pairs govern such conditions. Most production and quality factors in farm animals have equally complex inheritance. The size of the litter in swine, however, seems to be controlled largely by a simple dominant factor (according to Lush). The wild litter size (4) appears to be dominant to the larger litter size.

The factors which control the proportion of lean to fat in various portions of the hog are probably more environmental than genetic. It has been shown that the proportion of lean to fat in various cuts of swine can be controlled to a large degree by feeding practices. The application of the progeny testing, starting in Denmark and gradually spreading to other countries, should help greatly in establishing a universally desirable type. Market demands, however, often tend to alter the breeding plans considerably.

Productive Sheep Characters. The inheritance of production factors in sheep is very similar to that in swine. The wool and mutton characteristics of sheep have probably been combined more successfully than production characters in other types of livestock. Although several genetic factor pairs seem to influence most production characteristics in sheep, the application of genetic principles for improvement remains the same.

Some characters such as the length and curl of wool have been found to be influenced by one genetic factor. In most breeds the long curly type of wool is dominant to the short, straight type. The level of nutrition also appears to affect several production characters in sheep. The inheritance, for example, is not supposed to be due more to nutritional differences than to genetic differences.

Productive Horse Characters. The utility characters in horses are probably more easily observed than those in most farm animals. These useful characters include speed, strength, endurance, and resistance. It is evident that such factors will be greatly influenced by environment, but the genetic influences are also of considerable importance.

Various tests have been devised to measure the strength, endurance and speed of horses. The exact mode of inheritance is somewhat indefinite, but great progress has been made in the fixing of definite characters within a breed. The development of the hybrid mule has been of great importance to the farmer.

The mule has been bred largely for its endurance, resistance to heat and disease, and stability. Although horse-breeding is a very old enterprise, the application of genetic principles continues to produce desirable results.

Suggestive Questions

1. How is sex determined?
2. What is the order of dominance of cattle colors?
3. What are the more common recessive color patterns in cattle? What are the dominant patterns?
4. What are the chief differences in color inheritance in cattle and horses?
5. What are the differences in color inheritance in cattle and swine?
6. In what particulars does the inheritance of horns in sheep differ from that of cattle?
7. What are the more important lethal characters in livestock?
8. What is the evidence that vigor and vitality are inherited characteristics?
9. What are the proofs that size is an inherited character?
10. Why do we know that the inheritance of type, dairy and beef types, is complex?

Suggested Activities

1. Observe all the offspring of a bull and note what characteristics it transmits. Make special note of color and color patterns, horns, and udders.
2. From dairy herds where records are kept compare the production of the daughters of a bull with those of their dams.
3. Observe the colors and color patterns of crossbred pigs and ascertain the nature of the inheritance.

CHAPTER XIX

ORGANIZATIONS THAT HELP BREEDING

Ever since men became conscious of the desirability of improving livestock through breeding, attempts have been made to create organizations and systems that would be helpful. The first and perhaps most universally used organization was the livestock show, which was followed by the registry associations for all classes of purebred livestock. For the dairy breeds advanced registry was established and has persisted, with many modifications, through the years. Cow-testing associations have also been very helpful. In addition, co-operative bull associations have become very important instruments in breeding progress.

ORGANIZATIONS THAT SERVE BREEDERS OF PUREBREDS ONLY

The breeder of purebred livestock has access to the showring and several services rendered by various registry associations. The breeder of purebred dairy cattle, besides the usual services rendered by breed associations, has access to the advanced Registry and Herd Classification.

The Showring. Competitive showing of livestock has had a profound influence upon the breeding of all classes of livestock. Although the showring standards are not necessarily indicative of economical production, the showring is responsible for the establishment of definite standards toward which breeders can work. The keen competitive spirit that was developed has served as an added stimulus to breeders.

Although the showring still serves as the place where type standards are set with the development of systems of measuring the producing ability of livestock, it no longer serves as great a need as formerly.

Registry Associations. With the development of the purebreds came the formation of registry associations, usually known as breed associations. At first, these merely registered animals eligible for registration. Later, most of the breed associations assumed educational and promotional activities that have done much to promote better breeding practices. Most breed associations publish, or are closely associated with, breed journals that disseminate valuable information to breeders. A breeder of purebred livestock can not afford to be without the Breed Journal.

Advanced Registry. Mainly because dairy cattle lent themselves best to the keeping of production records, the dairy breed association developed an advanced registry system. To be eligible to the Advanced Register, a cow must have produced a certain minimum of milk or butterfat or a combination of both. Different breed associations and the same breed association at different times have had different standards.

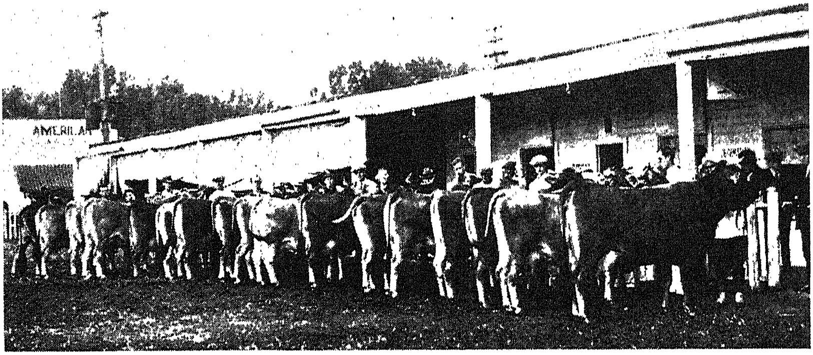


Figure 96. The livestock shows have contributed much to the improvement in livestock, although, by itself, it is inadequate as a guide in breeding.

Among the more important developments in the advanced registry are constant changes to make the records of greater value in formulating breeding programs. One of the significant developments has been the tendency to change from selecting a few cows to be tested to the testing of all cows in the herd. Another change has been the formation of classes that are adaptable to all conditions, such as classes for two-times-a-day milking as well as three or four-time milking. Classes are also provided for cows that carry their calves varying lengths of time during the test.

ORGANIZATIONS THAT SERVE ALL

For service to all, purebred and grades alike, there are three well-established organizations. These are Dairy Herd Improvement Associations, Sow-testing Associations, and Co-operative Bull Associations.

Herd Classification. One of the newest services rendered by dairy-breed associations is herd classification. The object of this service is to evaluate type. Any breeder of purebred cattle may, upon payment of a fee, have his herd classified by an expert judge. Each animal in the herd is scored and given one of the several classifications, which are: excellent, very good, good plus, good, fair, and poor.

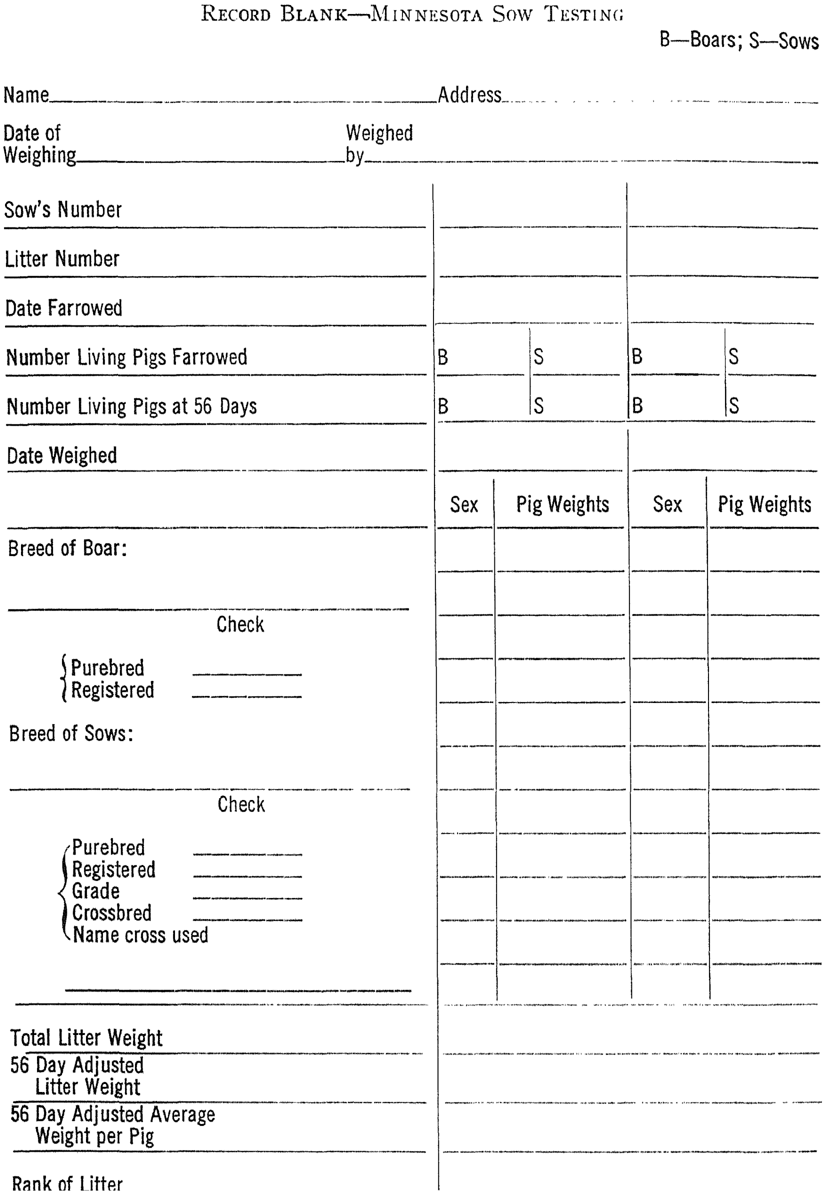
Dairy Herd Improvement Associations. Advanced registry testing is open only to purebred cattle. The breeder of grades is benefited in that the information furnished helps him to select his herd sire. For an intelligent breeding program, however, it is essential to have the same information on the grade cows. This may be obtained through the dairy herd improvement association, which organization is described in *Agriculture II*, page 321.

Sow-Testing. Although pig-testing has been practiced in Europe, particularly in Denmark, for a long time, it is only within recent years that swine raisers in this country have become interested to any extent in this important problem. Sow-testing, as now practiced, is the simplest of all records of performance. In its simplest form it consists merely of recording the weights of each pig of each litter at weaning time, or at 56 days of age, and then summating to determine the total weight of the litter. Observations have shown that nearly always the largest pigs and litter at weaning time will also be the largest at market time.

In addition to the average weight per pig and the total weight per litter, it is important to observe the uniformity of the pigs. Breeding stock should be selected from the litter having the greatest uniformity, largest average pig size, and largest litter weight. A convenient blank for recording the desired information is shown in Figure 97.

Weighing the pigs again at marketing time gives additional valuable information, and this practice is advised wherever it is possible. Still more valuable information may be obtained by having the carcasses graded for quality and taking the results into account when selecting breeding stock.

Co-operative Bull Association. A bull association is an organization of a number of farmers who jointly own a number of bulls. The first essential feature is that such an association be divided into a number of blocks with one bull to a block. A



RECORD BLANK—MINNESOTA SOW TESTING

B—Boars; S—Sows

Name________________________Address________________________

Date of Weighing________________________Weighed by________________________

Sow's Number				
Litter Number				
Date Farrowed				
Number Living Pigs Farrowed	B	S	B	S
Number Living Pigs at 56 Days	B	S	B	S
Date Weighed				
	Sex	Pig Weights	Sex	Pig Weights
Breed of Boar: ________________ Check Purebred ________ Registered ________ Breed of Sows: ________________ Check Purebred ________ Registered ________ Grade ________ Crossbred ________ Name cross used ________________				
Total Litter Weight				
56 Day Adjusted Litter Weight				
56 Day Adjusted Average Weight per Pig				
Rank of Litter				

Figure 97. A convenient form for keeping the essential information on pig litters. The full sheet contains eight more extra columns on the right. Courtesy, H. G. Zavoral.

block usually consists of several farmers having easy access to the place where the bull is kept; but, in the case of large herds, it may be a single farm.

The next important feature of a bull association is the exchange of bulls, when their daughters become of breeding age. It is essential that the order in which the bulls are to be moved is agreed upon in the beginning to avoid any controversy later.

The advantages of the co-operative bull associations are several. First, by pooling their resources, better bulls can be purchased than if each man bought his herd sire separately, and less money is invested in bulls, because fewer are needed. Secondly, the bulls are retained until their daughters come into milk, when they may better be evaluated. Bulls siring undesirable daughters are eliminated and new ones purchased to take their places. Provisions are made whereby, whenever superior bulls are discovered, their services are available for the best cows of all members of the association.

ARTIFICIAL INSEMINATION

While more or less general interest in artificial insemination has been aroused in this country, only within recent years the knowledge that females can be impregnated by artificial introduction of semen into the reproductive tract is not new. Arab horsemen are reported to have used artificial insemination as long as 600 years ago. In Denmark a large proportion of the cows has been artificially inseminated for the past several years, and in Russia artificial insemination is practiced extensively in both cattle and sheep.

In this country many artificial insemination associations, all for dairy cattle, are now operating and promise to be a great innovation in the field of dairying. The techniques involved, the advantages and disadvantages, and the types of organization are points that should be known by all breeders of livestock.

Techniques Used. Although there is still much to be learned about the technical aspects of artificial insemination, that phase of the problem is well developed for practical purposes. The important technical phases are: collection, examination, dilution, transport of the semen, and the act of inseminating.

Collection of the Semen. Semen may be obtained by one of two methods—massaging of the ampullae or collection of it in an artificial vagina. Collecting semen by massaging the ampulla through the rectum until ejaculation is effected and the semen is

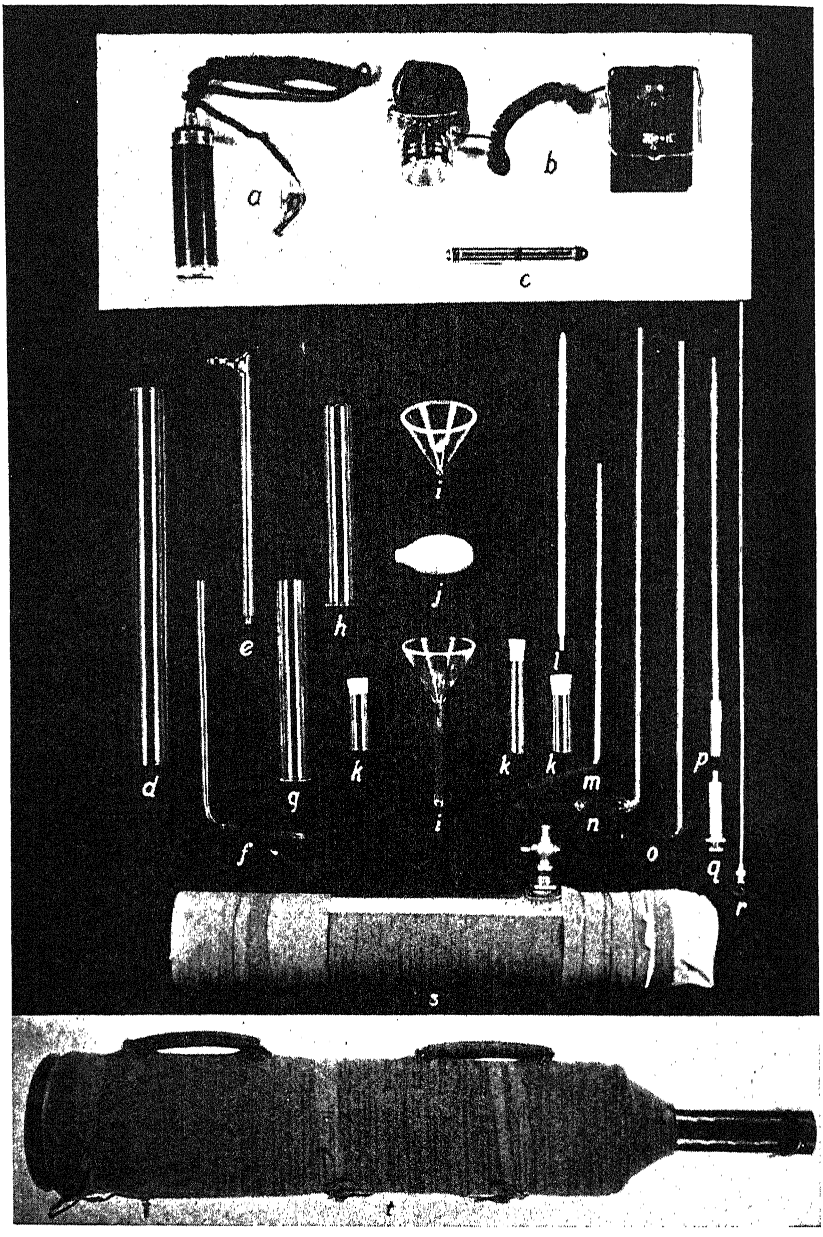


Figure 98. Instruments used in insemination. A, speculum light; B, head lamp; C, fountain pen type flashlight; D, cow speculum; E, collecting pipette (sheep); F, pipette used for flushing ewes and also collecting ram semen; G, sheep speculum; H, test tube used for dilator in sheep, heifers, and small cows; I, funnels; J, bulb used on collecting

caught in a beaker or test tube requires skill. The semen is also likely to be contaminated, and continued use of the method seems to have a deleterious effect upon the bull. The method is, therefore, not advised unless the bull is crippled.

Collection of semen by the use of an artificial vagina is the method commonly used. One type of artificial vagina is illustrated in Figure 98. It consists of an inner rubber tube, 2″ in diameter, open in one end, and a test tube attached to the other end. Around this tube is a jacket of larger diameter fitted so that it will hold water. Before use this jacket is filled with water (98 to 100° F.). The inner tube is coated with vaseline before use. The male is permitted to mount the female, when the operator directs the penis into the artificial vagina for ejaculation. The semen is then drained into the attached test tube.

Examination of the Semen. The importance of having potent semen is obvious. A great deal of expense can be saved by not sending out semen that has little chance of producing conception. It is, therefore, important that each sample of semen be examined microscopically before it is used. While one is not able to determine the fertilizing powers of all samples of semen by microscopic examination, specimens having abnormally shaped sperm, too few sperm, or sperm of low or no motility, are generally infertile and should not be used.

Dilution of Semen. One normal ejaculate contains ten or more times the number of sperm required for successful insemination. In order to have sufficient volume for that number of samples, it is necessary that the semen be diluted. It is common practice to use three volumes of a diluter for each volume of semen. There are many different diluters of which the egg-yolk buffer is most commonly used. This is made up of equal parts of fresh egg yolk and the buffer. The buffer is made up of 0.2 gram monobasic potassium phosphate and 0.8 gram disodium phosphate (U. S. P. dried) dissolved in 100 c.c. of water. Another satisfactory diluent has the following formula:

Sodium sulphate	13.6 grams
Dextrose	12.0 grams
Peptone	5.0 grams
Distilled water	3,000 c.c.

and inseminating pipettes; K, vials and test tube used for semen storage; L, thermometer; M, 1 cc. pipette used for sheep insemination; N, Minnesota type cow inseminating pipette; O, modified Minnesota type cow inseminating pipette; P, 1 cc. pipette used with Q, a 2 cc. hypodermic syringe, for inseminating cows; R, a metal tube (to be used with "Q") for inseminating cows; S, artificial vagina (bull or boar); T, artificial vagina (horse).

Storage of Semen. When more than two hours elapse between the time of collection and insemination, it is essential that the semen be cooled, else its viability will be lowered. The sperm must not be allowed to cool too rapidly; otherwise it will be injured. The most practical method is to wrap the test tube containing the semen in two or three thicknesses of paper and set it in a refrigerator at 45° F. until used.

Shipping of Semen. Very often it is necessary to ship semen long distances. In that case the cooled sample of semen is placed in a pint thermos bottle partly filled with water at 45° F. or even in ice water. The tube containing semen must be tightly stoppered and coated with paraffin to prevent contamination with water.

Inseminating Cows. Although the inseminating of cows by artificial means needs some technical skill, it can be mastered by almost anyone. In many states, however, insemination is done only by veterinarians. There are two general methods of introducing semen into the female. One is merely to deposit it in the vagina near or at the os of the uterus for which purpose a speculum may be used. The other is to deposit the semen in the cervex. This method necessitates inserting the inseminating instrument into the cervex. It is accomplished by inserting one hand into the rectum to guide the direction of the instrument.

Different types of instruments that may be used in artificial insemination are illustrated in Figure 98.

Advantages. The more important advantages of artificial insemination are:

1. The use of superior sires may be increased many fold. Instead of siring a few calves in one herd, a bull may, by use of artificial insemination, sire several hundred calves annually.

2. Small breeders may get the services of superior bulls, as would not be possible otherwise on account of the cost of good proven bulls.

3. For the smaller herds, at least, the annual cost of bull service is lowered. It costs about the same to feed and care for a bull as for a good producing cow. The annual bull cost may, therefore, be calculated as equal to the total annual income from a good cow.

4. Young bulls can be proved sooner and without any great financial risk, as only one or two cows in any herd need be bred to a bull before he is proved.

5. Conception rates are higher by artificial insemination because of the examination of the semen before it is used.

6. Nonbreeding bulls are detected more quickly and there is not so much loss from the use of infertile bulls.

7. By careful controls and checks dissemination of disease by bulls is lessened.

8. Crippled bulls of merit may be used.

9. A long-time constructive breeding program for both the individual and the community may be developed.

ESSENTIAL FEATURES OF ASSOCIATIONS

There are many variations in the setups of different artificial insemination associations, but the more essential features are identical to all. The first requirement is that enough services must be contracted to make the association economical. A minimum of 1,200 cows is essential and 2,000 is still better.

A second requirement is that a suitable place be furnished for housing the bulls and for a laboratory. The laboratory must be equipped with a refrigerator, a microscope, and facilities for washing and sterilizing the equipment.

At least three bulls of each breed should be acquired to prevent embarrassment from infertile bulls.

A veterinarian must be engaged who will be responsible for the health of the bulls and who supervises the sanitary regulations when lay inseminators are employed.

To avoid excessive costs in traveling, the membership should be within 25 miles of the point where the semen is obtained by the inseminator.

Sufficient charges per insemination must be made to provide adequate finances for the organization. It is better to have excess charges and prorate surpluses to the members than to undercharge.

Next to selecting good bulls, the most important requirement of an artificial insemination association is a management that understands and can give direction to the breeding operations.

The manager of an artificial insemination association should understand the principles of genetics and their application to breeding problems. He should also have business ability and a personality that inspires confidence of the membership. With the proper organization and the right kind of a manager, the artificial insemination association can be the most influential factor in the improvement of livestock in a community.

A typical members' agreement and by-laws are found on page 355 in the Appendix.

Suggestive Questions

1. In what ways has the showring contributed to livestock improvement?
2. How do breed associations serve the breeder?
3. What is meant by advanced registry and of what value has it been to dairy cattle breeders?
4. What is meant by herd classification?
5. Give five reasons why dairymen should have their cows entered in a dairy herd improvement association.
6. Describe a system of sow testing and its value to swine breeders.
7. What are the advantages and disadvantages of a co-operative bull association?
8. What are the essential features of an artificial insemination society?
9. Give the chief advantages of artificial insemination.

Suggestive Activities

1. Write the secretary of the breed association in which you are most interested for the literature available from his office.
2. Obtain the necessary blanks for registration of your favorite breed and fill them in.
3. Make note of the number of items in the recent issues of a breed journal that are of specific value to the breeders.
4. Visit an artificial insemination society. Observe the bulls, methods of collecting, diluting, and shipping the semen.

CHAPTER XX

BREEDING POULTRY

Although the basic principles of inheritance are the same for poultry as for other classes of farm livestock, there are important differences. These differences make it desirable to treat the breeding of poultry separately from that of other farm animals. There are three main objectives in poultry breeding: approved type, egg production, and meat production. The poultry breeder should be familiar with the known genetic facts so that he may best obtain the desired results.

INHERITANCE

The inheritance of some of the more important characters of poultry will be considered briefly, followed by methods of breeding, and, a section on organizations that aid the poultry breeder.

SEX

As has been previously indicated, sex is inherited differently in poultry than in mammals. The male in poultry is homozygous, that is, he possesses two sex chromosomes, so that all spermatozoa contain one sex chromosome. The female has but one sex chromosome, producing two kinds of female sex cells, one containing a sex chromosome; the other, none.

Although it is possible that some characters are located on the sex chromosome in cattle, proof has not been established. In poultry, several such characters (known as sex linkage) are known, and practical use is made of them in early determination of sex. Broodiness, early sex maturity, and barred feathers are the three more important sex-linked dominant characters. Another sex-linked character, partly recessive, is well-developed wing feathers in the day-old chick.

The barred feather and the well-developed wing feathers in day-old chicks are of advantage in early sexing of chicks. Since the son always receives one of its two sex chromosomes from the mother, while the daughter receives none, any dominant sex-linked character will always be transmitted from mother to son and never from mother to daughter. Barred plumage is such a character. When Barred Plymouth Rock females are mated to White Wyandotte, Buff Plymouth Rock, or Rhode Island Red males, the male chicks are black on top of the body with a white spot on the head and the shanks and beaks are yellow. The females from such a cross are of solid black on top of the body with dark shanks and beaks.

When the sex-linked character is recessive, then females carrying the factor will possess the character, because they have but one sex chromosome, while the males must be homozygous before the character will appear. The factor for well-feathered wings in day-old chicks is of that nature. In crosses of males from the Mediterranean class with females of American, Asiatic, and English classes the females have well-feathered wings and the males have normal wings when a day old.

COLOR

In poultry the plumage, skin, and shank may or may not be pigmented. The plumage may be white, black, buff, or barred. There are two types of inheritance for white plumage. In one the white of the Leghorn is dominant to color and in the other the white of Wyandottes and Plymouth Rocks is recessive to color.

Black is dominant to the recessive white and buff. Barred plumage is dominant to the nonbarred condition but is recessive to the dominant white.

White skin and shank is dominant to yellow skin and shank.

ANATOMY

There are several anatomical characters of importance to the breeder of purebred poultry, the inheritance of which is well known. Among these are: the character of the comb, feathering on the shanks, closeness or looseness of feathering, and slow or rapid feathering.

The rose comb is dominant to the single comb and side sprigs on the comb are dominant to the normal comb. Feathered shanks are dominant to nonfeathered shanks. Close feathering is dominant to loose feathering. Fast feathering is recessive to slow feathering. The latter character is sex-linked, and, as previously stated, all daughters of a male, homozygous for slow feathering, are slow in feathering.

LETHALS

A goodly proportion of the losses during incubation is due to lethal factors, the nature of the inheritance of which is not well known. Crosses of creeper chickens with normals produce 2 creepers for each normal, whereas the ratio should be 3 creepers for each normal. One of each 4 in such a cross is eliminated by a lethal gene. Another lethal gene in the homozygous state causes what is known as "sticky embryo."

PRODUCTION

The inheritance of production characters in poultry is complex. Although much progress has been made in the study of the inheritance of the various characters that make for profitable birds, much remains to be done. Among the characters that fall in this class and for which inheritance is an important factor are: hatchability, vigor, rate of growth, broodiness, laying capacity, persistency, egg size and quality, meat production, and resistance to disease.

Hatchability. The desirability of having eggs with high hatchability is obvious. Much of the difficulty with poor hatchability is due to improper management and feeding, but inheritance is also important. The nature of the inheritance of hatchability is complex. That inheritance is a big factor is proven by the results from inbreeding and also by selecting strains with high hatchability. In inbreeding a marked lowering in hatchability is commonly observed. By rigorous selection hatchability may be improved.

Vigor. As for other species, there is a marked variance in vigor among poultry. That inheritance is an important factor in this character is abundantly proved by breeding experiments. Inbreeding invariably causes marked losses in vigor, and outcrossing and crossbreeding cause increased vigor.

Rate of Growth. No other character is so greatly influenced by management and feeding practices as the rate of growth, and yet there is much evidence that inheritance is also an important factor. Birds that grow rapidly mature earlier and come into production sooner than those that grow more slowly.

The inheritance for rapid growth involves many factors, and, therefore, breeding for this quality requires long and careful selection of the breeding birds from strains and families that grow rapidly.

Broodiness. Broody hens do not lay; consequently it is necessary to select breeding stock that is not broody. Although the inheritance of this character is probably due to more than one factor, it is relatively simple. Fortunately, broodiness is dominant to nonbroodiness. It is, therefore, comparatively easy to "breed out," as nonbroody stock do not carry the factor for broodiness.

Capacity for Laying. As for many other desirable characters the number of eggs produced is dependent on the feed and care the birds are given. It has long been known, however, that many birds are poor layers regardless of the feed and care they receive to show that inheritance is an important factor. As would be expected, the capacity for high egg production is due to many genetic factors. High-producing hens may have many poor factors for laying, and, therefore, as with dairy cattle, the mating of high-producing females to males out of high-producing females does not insure desirable offspring.

Broodiness, lack of persistency, and long pauses in egg-laying are prominent factors in low total egg production. Selection to avoid these undesirable characters will do much to increase yearly egg production.

Persistency. By persistency is meant a long period of continuous laying. Although feeding and management are prominent factors in persistency, inheritance is also very important. Many experiments have shown that by careful selection of breeding stock from families with good persistency the number of days that hens lay can be materially increased.

A common characteristic in poultry that may be regarded as a factor in persistency is the tendency to quit laying for varying periods during the year. This characteristic is known as a pause. Although pauses may be due to poor feeding and management, they are also an inherited character which is dominant to continuous laying. Being a dominant factor, the pause is comparatively easy to "breed out," as only birds not possessing the character need be selected to eliminate it completely.

Egg Size and Quality. As the price that eggs command is dependent upon the size, color, and quality of the egg, the importance of producing large eggs of high quality is obvious. There are three important factors to consider: size of the egg, color of the shell, and interior quality.

It is well known that the interior quality of eggs is markedly influenced by feeding and management. Heredity also is an important factor, although the nature of the inheritance is not understood. The relative amount of thick white to total white and, to some extent, the color of the yolk are due to genetic factors.

Genetic Factors. There are many factors that affect egg size many of which are genetic. Among the nongenetic factors are age of the hen and the season of the year. Young pullets lay small eggs and all eggs laid during the hot summer months tend to be smaller. Eggs also tend to be smaller toward the end of the laying season, particularly among heavy-producing hens.

The genetic factors influencing egg size are complex. Factors affecting the size of the hen also affect egg size, as there is a strong tendency for large birds to lay large eggs.

Shell Color. Although there is no correlation between shell color and the quality of an egg, uniformity of color is an important market requirement. Some variation in shades is tolerated among brown eggs, but tinted eggs among white are objectionable to a discriminating market. As the coloring of the egg shell is due to genetic factors, the problem of color can be solved only by the proper selection of breeding stock.

Meat Production. Selecting poultry for meat production presents essentially the same problems as selecting cattle for beef production. The inheritance is probably equally complex, as it requires the same methods of breeding.

Resistance to Disease. Inherited resistance to disease is better established in poultry than in any other class of farm animals. There has been much success in breeding poultry for resistance to pullorum and fowl typhoid by merely breeding from stock that did not contract the disease in infected flocks. Inherited resistance to range paralysis and roundworm infestation has also been reported.

BREEDING

Poultry breeders resort to the same systems of breeding used by breeders of other classes of farm animals and, therefore, no further discussion of this topic is necessary.

Methods. Methods to be used in improving poultry are not different from those that should be employed in the breeding of other species. Because of the large number of progeny from one bird and the short life cycle more rapid improvement can be expected in poultry than in other species of farm animals.

Objectives. The most important objective in poultry-raising is large egg production. To attain this end it is essential that rigid selection and proper analysis be made of the breeding stock. Merely mating high-producing females to males out of high-producing females will not accomplish the objective. As has been repeatedly said, a sound breeding program for any species can not be promoted without progeny testing. The same rule maintains for poultry. Only birds that are known to transmit the desirable characteristics should be used.

AIDS FOR POULTRY IMPROVEMENT

The poultry breeder has available several instruments of practical value in carrying out a sound breeding program. The oldest of these is the poultry show. As for other livestock, the showring has done much to fix the type for each breed. Poultry organizations with their journals are also very helpful instruments. The most important organizations for poultry improvement are of recent origin. Most states have some kind of poultry breed improvement program. In 1935 the United States Department of Agriculture established the National Poultry Improvement Plan.

The National Poultry Improvement Plan is in two parts: breeding stages and pullorum control and eradication.

Breeding Stages. Under the National Poultry Improvement Plan there are five breeding stages. In all these the birds must be banded and complete records kept. Although the plan is sponsored by the United States Department of Agriculture, the state supervision is under the direction of a duly appointed officer in either the State Agricultural College or another authorized state agency.

The five stages with their qualifications are:

1. U. S. Approved Flocks. The females are rigidly and thoroughly selected once each year by the state inspector for constitutional vigor and for egg production. These selected females must combine standardbred and production qualities to a reasonably high degree. The males are selected especially for constitutional vigor and standardbred qualities. None other than U. S. approved birds may be permitted in the breeding flock.

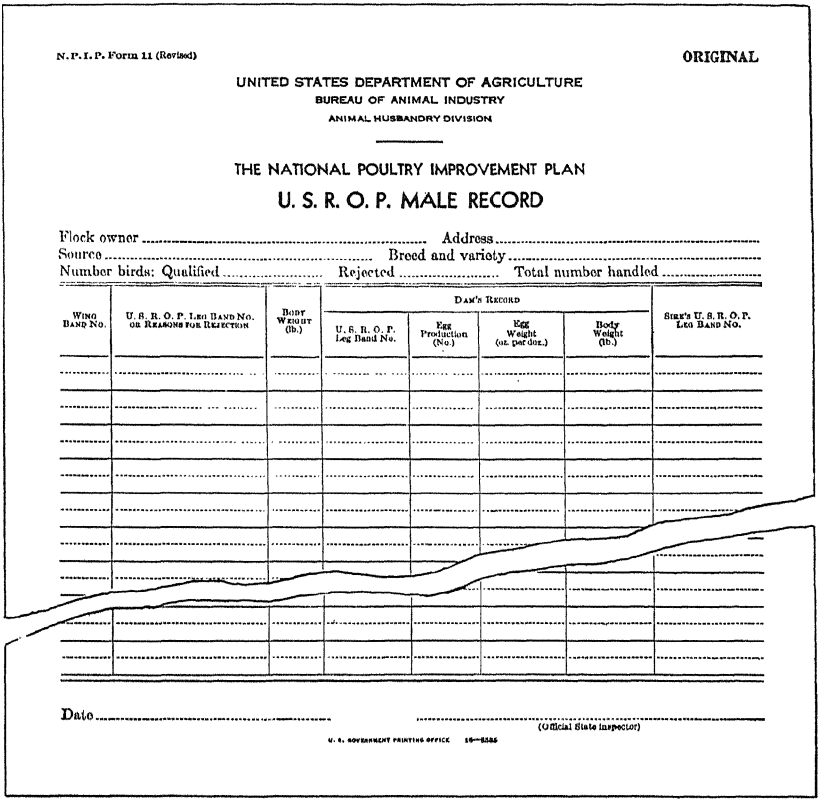
U. S. approved hatching eggs must come from U. S. approved flocks of higher breeding stage and must weigh at least 1-11/12 ounces each. Chicks hatched from such eggs may be classed as U. S. approved chicks.

2. U. S. Verified Breeding Stage. To qualify for this stage the flock must meet all the requirements for the U. S. approved flocks and shall

be mated to males produced from flock matings of U. S. R. O. P. females and U. S. R. O. P. males.

U. S. Certified hatching eggs are from U. S. Certified flocks and must weigh at least 1-11/12 ounces each. U. S. Verified chicks must be from U. S. Verified eggs.

3. U. S. Certified Flocks. To qualify for this breeding stage all the requirements of the U. S. Approved flocks must be met and only U. S. R. O. P. males may be used.



N. P. I. P. Form 11 (Revised) **ORIGINAL**

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ANIMAL INDUSTRY
ANIMAL HUSBANDRY DIVISION

THE NATIONAL POULTRY IMPROVEMENT PLAN

U. S. R. O. P. MALE RECORD

Flock owner .... Address ....
Source .... Breed and variety ....
Number birds: Qualified .... Rejected .... Total number handled ....

Wing Band No.	U. S. R. O. P. Leg Band No. or Reasons for Rejection	Body Weight (lb.)	Dam's Record				Sire's U. S. R. O. P. Leg Band No.
			U. S. R. O. P. Leg Band No.	Egg Production (No.)	Egg Weight (oz. per doz.)	Body Weight (lb.)	

Date ....

....
(Official State inspector)

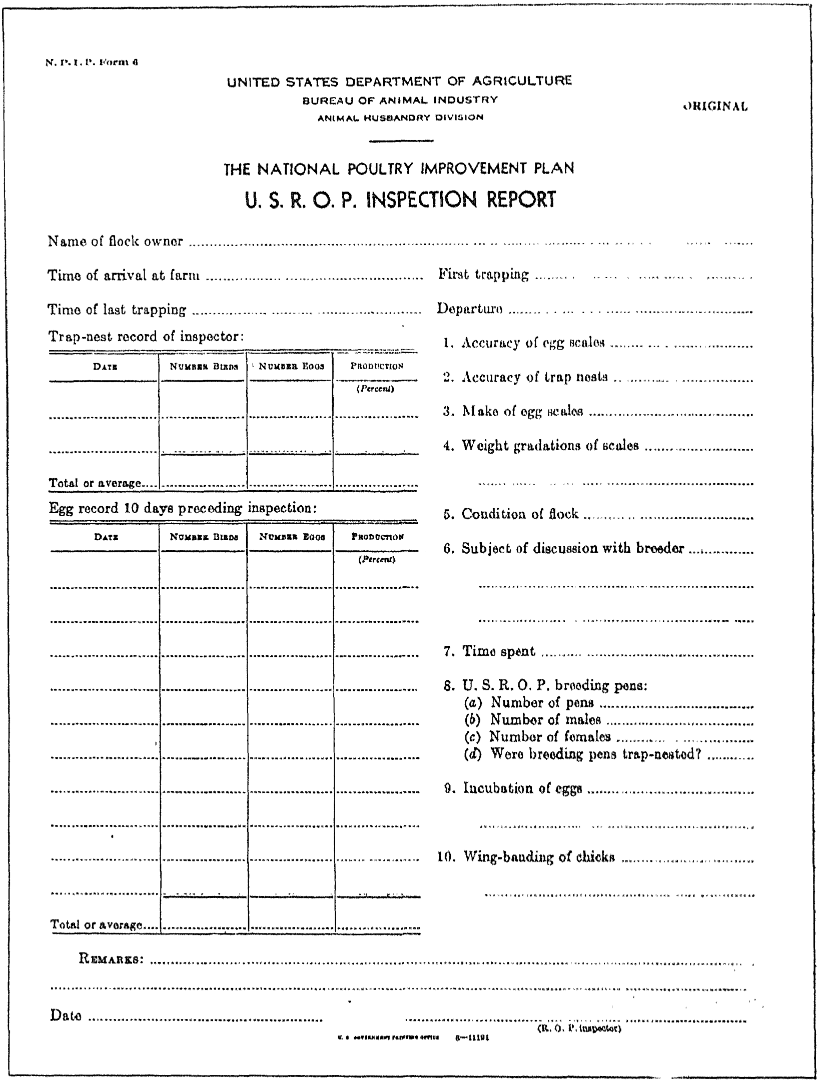
U. S. GOVERNMENT PRINTING OFFICE 16—6585

Figure 99. The National Poultry Improvement Plan. U. S. R. O. P. Male Record.

U. S. Certified hatching eggs are from U. S. Certified flocks and must weigh at least 1-11/12 ounces each. Chicks from such eggs are U. S. Certified chicks.

4. U. S. Register of Performance Breeding Stage. This stage, usually known as U. S. R. O. P. requires that records of egg production for each hen as well as weight of the eggs be kept.

U. S. R. O. P. hens must produce at least 200 eggs during the first year. The eggs must average at least 24 ounces per dozen, and must be of normal shape and color.



N. P. I. P. Form 6

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ANIMAL INDUSTRY
ANIMAL HUSBANDRY DIVISION

ORIGINAL

THE NATIONAL POULTRY IMPROVEMENT PLAN

U. S. R. O. P. INSPECTION REPORT

Name of flock owner ....

Time of arrival at farm .... First trapping ....

Time of last trapping .... Departure ....

Trap-nest record of inspector:

Date	Number Birds	Number Eggs	Production
			(Percent)
Total or average....			

Egg record 10 days preceding inspection:

Date	Number Birds	Number Eggs	Production
			(Percent)
Total or average....			

1. Accuracy of egg scales ....
2. Accuracy of trap nests ....
3. Make of egg scales ....
4. Weight gradations of scales ....
5. Condition of flock ....
6. Subject of discussion with breeder ....
7. Time spent ....
8. U. S. R. O. P. breeding pens:
   - (*a*) Number of pens ....
   - (*b*) Number of males ....
   - (*c*) Number of females ....
   - (*d*) Were breeding pens trap-nested? ....
9. Incubation of eggs ....
10. Wing-banding of chicks ....

Remarks: ....

Date ....
(R. O. P. inspector)

U. S. GOVERNMENT PRINTING OFFICE 8—11191

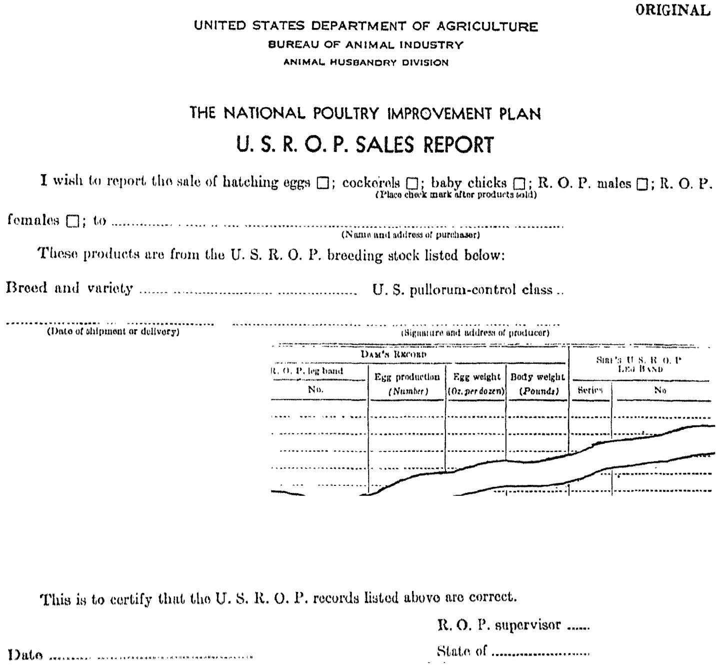
Figure 100. The National Poultry Improvement Plan. U. S. R. O. P. Inspection Report.

U. S. R. O. P. males must be from U. S. R. O. P. eggs—that is, eggs from U. S. R. O. P. flocks.

In addition to the above requirements, both males and females must be of normal size and free from all disqualifications in order to qualify as U. S. R. O. P.

5. U. S. Register of Merit Stage. To qualify for this stage, usually known as U. S. R. U. M., a male must meet the requirements of the U. S. R. O. P. and in addition have at least one third of his daughters, with a minimum of twenty, qualify for U. S. R. O. P.

A U. S. R. O. M. female is a U. S. R. O. P. female that has a minimum of four and not less than one third of all her daughters qualify for U. S. R. O. P.



ORIGINAL

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ANIMAL INDUSTRY
ANIMAL HUSBANDRY DIVISION

THE NATIONAL POULTRY IMPROVEMENT PLAN

U. S. R. O. P. SALES REPORT

I wish to report the sale of hatching eggs ☐; cockerels ☐; baby chicks ☐; R. O. P. males ☐; R. O. P. females ☐; to ....
(Place check mark after products sold) (Name and address of purchaser)

These products are from the U. S. R. O. P. breeding stock listed below:

Breed and variety .... U. S. pullorum-control class ..

....
(Date of shipment or delivery) (Signature and address of producer)

Dam's Record				Sire's U. S. R. O. P. Leg Band	
R. O. P. leg band No.	Egg production (Number)	Egg weight (Oz. per dozen)	Body weight (Pounds)	Series	No

This is to certify that the U. S. R. O. P. records listed above are correct.

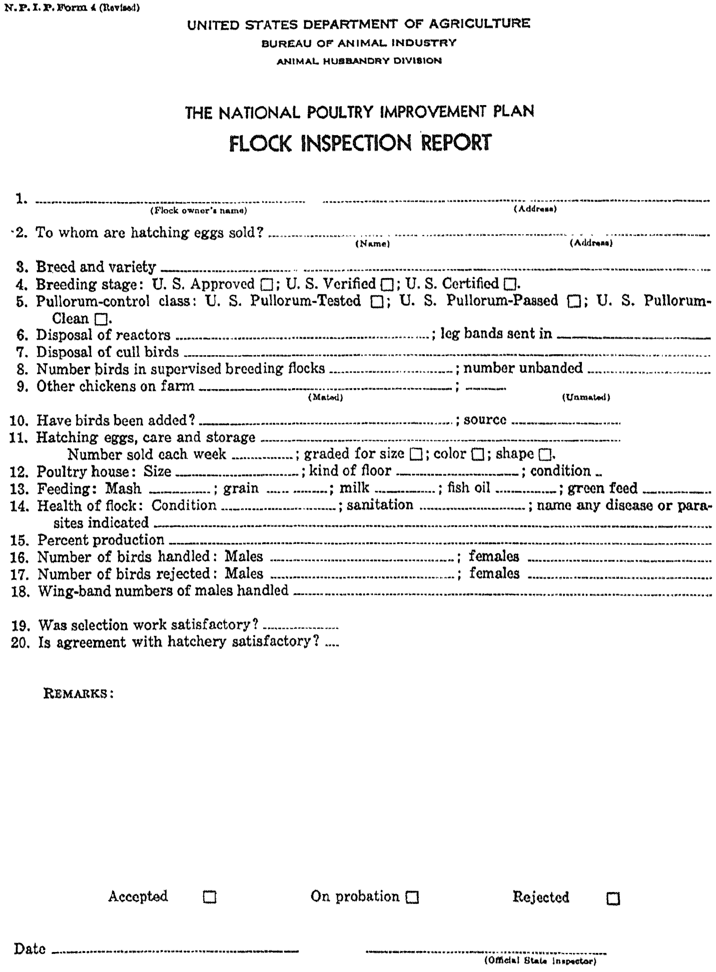
R. O. P. supervisor ......
State of ....
Date ....

Figure 101. The National Poultry Improvement Plan. U. S. R. O. P. Sales Report.

Pullorum Control and Eradication Classes. As with the breeding stages program, the pullorum control and eradication plan is sponsored by the U. S. Department of Agriculture but is administered in the several states by state agencies. There are three classes as follows:

1. U. S. Pullorum-Tested Class. In order that a flock may qualify for this classification, all chickens four months old or older to be used as breeders must be tested by one of the approved tests for pullorum within 12 months and in 1942-43 fewer than 8 per cent can be reactors.

The per cent of allowable reactors shall decrease by one until 1945-46 when less than 5 per cent may be positive to the test. It is necessary then, to dispose of all reactors.



N. P. I. P. Form 4 (Revised)

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ANIMAL INDUSTRY
ANIMAL HUSBANDRY DIVISION

THE NATIONAL POULTRY IMPROVEMENT PLAN

FLOCK INSPECTION REPORT

1. .... (Flock owner's name) .... (Address)
2. To whom are hatching eggs sold? .... (Name) .... (Address)
3. Breed and variety ....
4. Breeding stage: U. S. Approved ☐; U. S. Verified ☐; U. S. Certified ☐.
5. Pullorum-control class: U. S. Pullorum-Tested ☐; U. S. Pullorum-Passed ☐; U. S. Pullorum-Clean ☐.
6. Disposal of reactors ....; leg bands sent in ....
7. Disposal of cull birds ....
8. Number birds in supervised breeding flocks ....; number unbanded ....
9. Other chickens on farm .... (Mated); .... (Unmated)
10. Have birds been added? ....; source ....
11. Hatching eggs, care and storage ....
Number sold each week ....; graded for size ☐; color ☐; shape ☐.
12. Poultry house: Size ....; kind of floor ....; condition ....
13. Feeding: Mash ....; grain ....; milk ....; fish oil ....; green feed ....
14. Health of flock: Condition ....; sanitation ....; name any disease or parasites indicated ....
15. Percent production ....
16. Number of birds handled: Males ....; females ....
17. Number of birds rejected: Males ....; females ....
18. Wing-band numbers of males handled ....
19. Was selection work satisfactory? ....
20. Is agreement with hatchery satisfactory? ....

REMARKS:

Accepted ☐ On probation ☐ Rejected ☐

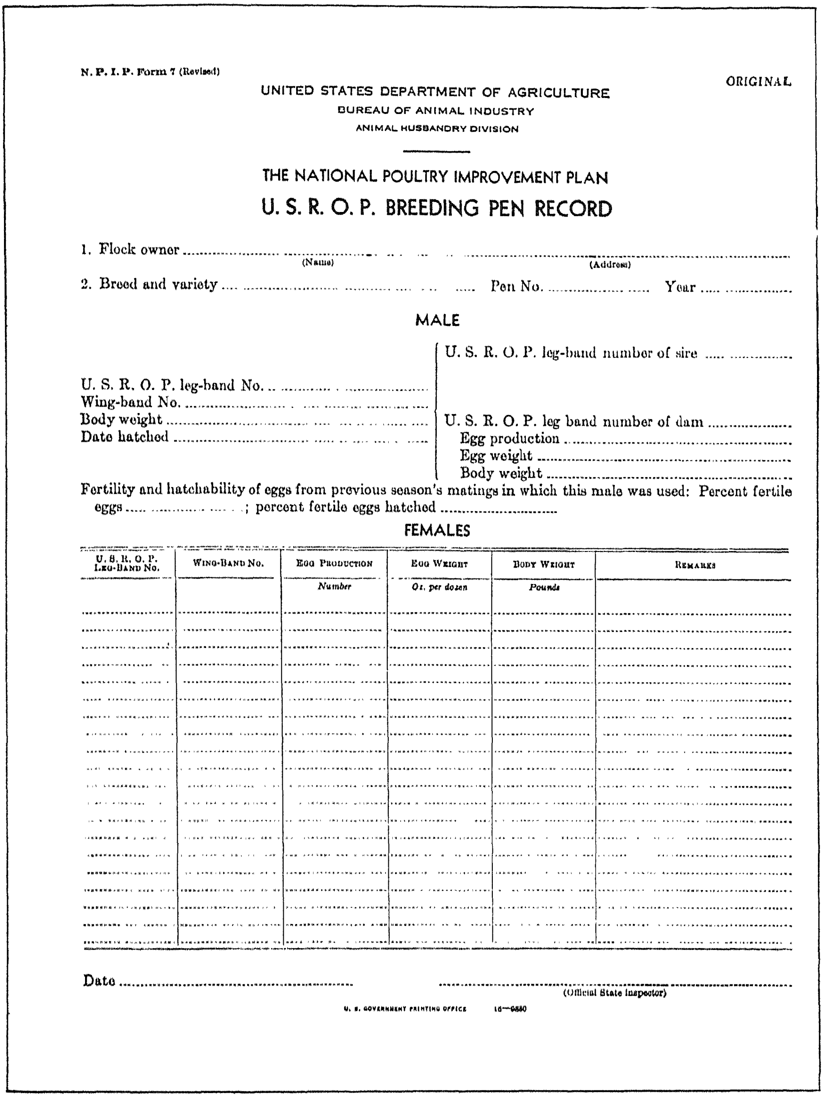
Date .... (Official State Inspector)

Figure 102. The National Poultry Improvement Plan. Flock Inspection Report.

2. U. S. Pullorum-Passed Class. For a flock to qualify for this class there must have been no reactors to pullorum on the last test.

3. U. S. Pullorum-Clean Class. To qualify for this class flocks must have passed, without any reactors, two consecutive pullorum tests not less than six months apart.

Essential blank forms for record-keeping and reporting by inspectors are reproduced in Figures 99-103.



N. P. I. P. Form 7 (Revised)

ORIGINAL

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ANIMAL INDUSTRY
ANIMAL HUSBANDRY DIVISION

THE NATIONAL POULTRY IMPROVEMENT PLAN

U. S. R. O. P. BREEDING PEN RECORD

1. Flock owner .... (Name) .... (Address)

2. Breed and variety .... Pen No. .... Year ....

MALE

U. S. R. O. P. leg-band No. ....
Wing-band No. ....
Body weight ....
Date hatched ....

U. S. R. O. P. leg-band number of sire ....

U. S. R. O. P. leg band number of dam ....
Egg production ....
Egg weight ....
Body weight ....

Fertility and hatchability of eggs from previous season's matings in which this male was used: Percent fertile eggs ....; percent fertile eggs hatched ....

FEMALES

U. S. R. O. P. Leg-Band No.	Wing-Band No.	Egg Production	Egg Weight	Body Weight	Remarks
		Number	Oz. per dozen	Pounds	

Date .... (Official State Inspector)

U. S. GOVERNMENT PRINTING OFFICE 16—6880

Figure 103. The National Poultry Improvement Plan. U. S. R. O. P. Breeding Pen Record.

Suggestive Questions

1. What is the nature of the inheritance of sex in the fowl?
2. What is the nature of the inheritance of plumage color and patterns?
3. What is the nature of the inheritance for: Comb? Feathered shank? Close feathering? Fast feathering?
4. What are the more important lethal characters in chickens?
5. What is the nature of the inheritance of broodiness?
6. What are three important inherited characters that contribute to total egg production?
7. What inherited factors are involved in size and quality of the eggs?
8. What diseases in poultry may have inherited resistance?
9. Describe a sound rule for improvement of poultry by breeding.
10. What organizations have aided in poultry breeding?

Suggestive Activities

1. Make appropriate crossmatings and separate the chicks according to sex.
2. Collect the eggs from a flock. Note the color, determine the size, and grade them.
3. Obtain the necessary blanks and prepare plans for entering a flock in each of the five breeding stages.

APPENDIX

APPENDIX

SAMPLE FORM OF ARTICLES OF INCORPORATION OF AN ARTIFICIAL INSEMINATION ASSOCIATION

Article 1. The name of this association shall be.................. ...., and its location shall be in the City of...................., County of ...., State of ...., P. O. address........................

Article 2. The purposes of this association shall be to promote and encourage the organizing of calf clubs, bull associations, herd improvement associations, breeding projects, disease eradication, consignment sales, club tours, field days, and such other activities that tend to improve the herds of its members and benefit the dairy industry; to purchase, own, hire or lease purebred animals and make them available to its members; to employ competent veterinarians and make their services available to its members; keep adequate breeding records and assist its members in acquiring information relative to breeding methods and control of animal diseases; purchase, own, lease and acquire such real estate as may be needed in the operations of the association, and do any and all other things necessary or incident to the transacting of the business of the association.

Article 3. This association is formed without capital stock.

Article 4. The method and conditions upon which members shall be accepted, discharged or expelled are the following: Any member may be accepted or discharged upon a two-thirds vote of the directors of the association. The original charge for membership shall be Five and no/100 Dollars ($5.00) and such additional charges for special services as are provided for by contract, which contract, however, shall be uniform as to each member. Each member must by agreement agree to abide by all of the rules and by-laws of the association adopted pursuant to law. Membership shall be for a period of not less than one year, and each member's contract shall be automatically renewed for a year unless within thirty days preceding the termination of each year, notice in writing be given by the member to the association of his intention to withdraw.

Article 5. The property rights of members of this association shall be equal. The property rights of members of this association shall be established in conformity with Section 185.165 of the Wisconsin Statutes of 1937, but shall not be governed by any acts amendatory thereof or supplementary thereto which are in effect alterations or revisions of said statute as it now exists.

Article 6. The number of directors of this association shall be five (5).

Article 7. The officers of this association shall be a president, vice-president, secretary and treasurer. The principal duties of the president shall be to preside at all meetings of the members and of the board of directors and with said board to have general supervision of the affairs of the association. He shall sign all certificates of membership and all contracts and other instruments; provided, that the board of directors may authorize any officer or agent of the association to perform this duty unless prohibited by law. The principal duties of the vice-president shall be to discharge the duties of the president in the event of the absence or disability of the latter. The principal duties of the secretary shall be to keep a true and correct record of the proceedings of the board of directors, and to safely and systematically keep all books, papers, records and documents belonging to the association or pertaining to the business thereof. He shall countersign and affix the seal of the association to such papers and documents as shall be required to be so countersigned or sealed; provided, that the board of directors may authorize any officer or agent of the association to perform this duty, unless prohibited by law. The principal duties of the treasurer shall be to safely keep and account for all moneys and other property of the association which shall come into his hands, and to keep an accurate account of all moneys received and disbursed by him and to retain proper vouchers for all moneys disbursed, and to render such accounts, statements, and inventories as may be required by the board of directors. The board of directors may require that the offices of secretary and treasurer be combined in the office of secretary-treasurer. The officers of the association shall perform such additional duties as may from time to time be imposed by the board of directors or as may from time to time be prescribed by the by-laws.

Article 8. The officers shall be elected by the Directors, who shall first be elected by the members of said association.

Article 9. The association may amend its articles of incorporation by a majority vote of its members at any regular or special meeting, legally called, except the article pertaining to property rights, which shall not be amended or repealed except by a vote of at least three-fourths of the members. The association may dissolve by a vote of at least a majority of the members.

Article 10. The names of the persons forming this association are:

BY-LAWS OF THE . . . . . COUNTY BREEDERS CO-OPERATIVE

ARTICLE I. Articles of Incorporation

Section 1. The provisions of the Articles of Incorporation are hereby made a part of these By-Laws.

ARTICLE II, Meetings

Section 1. An Annual Meeting of the Association shall be held on .... at ....

Section 2. The President may call special meetings. He shall call special meetings upon a majority vote of the Directors or upon a written demand, signed by at least twenty per cent of the members of the Association.

Section 3. Meetings of the Association shall be held in the city of ...., in such suitable building as the Directors may designate.

Section 4. Notice of meetings shall be mailed to all members at their last known address as shown on records of the Association. Such notices shall be mailed not less than seven nor more than twenty days previous to meeting.

Section 5. Notice of special meetings shall state purpose of the meeting. Notice of special meetings called upon demand of the members shall state the purpose to which the demand relates.

Section 6. Notice of meetings may be published in the leading newspapers of the city of ....

Section 7. The Order of Business shall be in accordance with Robert's Rules of Order.

ARTICLE III, Quorum

Section 1. Twenty per cent of the members shall constitute a quorum at any meeting of the Association. Said quorum shall be present in person.

ARTICLE IV, Voting Rights and Privileges

Section 1. A member shall be entitled to one vote. Members who have ceased to own livestock for which service is furnished by the Association for a period of more than one year shall lose the right to vote and shall be ineligible to hold an office in the Association.

Section 2. Voting by proxy or cumulative voting will not be permitted.

ARTICLE V, Membership

Section 1. Any owner of livestock shall be eligible for membership under the following conditions:

a. That he pay a membership fee of 5.00.
b. That he signs a membership agreement.
c. That for the term of his membership agreement he will avail himself of all of the services made available to him by the Association for the number of livestock contracted for in the membership agreement that is owned or controlled by him in the territory tributary to the center served by the Association.

ARTICLE VI, Board of Directors

Section 1. The Board of Directors shall consist of five members who are owners of livestock and are using all of the services that are available to them by the Association.

Section 2. At the first annual meeting of the Association, two directors shall be elected for a period of three years, two for a period of two years, and one for a period of one year. Thereafter, the directors shall be elected for a term of three years to serve until their successors have been elected, qualified and enter upon discharge of their duties.

Section 3. The nomination of directors at the organization meeting shall be by a nominating committee appointed by the chairman of the meeting. At future elections, the directors shall be nominated by a nomination ballot.

Section 4. Vacancies occurring on the Board of Directors may be filled until the next annual meeting by remaining members of the Board. At the next annual meeting of the Association the vacancy shall be filled by election.

Section 5. The Directors shall hold an organization meeting within fifteen days after the annual Association meeting. At this meeting they shall elect from among themselves a President and Vice-President. They shall at the same time elect a Secretary-Treasurer who may or may not be a Director.

Section 6. The President may call a meeting of Directors at any time. He shall call such a meeting upon demand of a majority of the Directors.

Section 7. Notice of Directors' meetings shall be sent to each Director in person, by mail, telephone or telegraph at a reasonable time preceding a meeting. A meeting may be held on waiver of notice provided all members are present.

Section 8. The Compensation of Directors attending any regular or special Directors' meeting shall be $3.00 per day. No allowance for mileage.

Section 9. The Board of Directors shall conduct, manage and control affairs of the Association. Make rules and regulations not inconsistent with law or these By-Laws for management of the business and guidance of officers, employees and agents of the Association.

Section 10. The Board of Directors is hereby authorized to borrow money and pledge the assets and notes of the Association as security. To purchase, lease, acquire or sell real and personal property in the name of the Association.

Section 11. The Board of Directors shall set up such reserves as are authorized.

Section 12. The Board of Directors shall have power to employ and dismiss a veterinarian. They shall have the power to fix the salary and duties of all persons that may be employed by the Association..

Section 13. The veterinarian and all officers, employees and agents having custody of funds or property of the Association shall give bond through a responsible surety company in an amount to be fixed by the Board of Directors, for faithful performance of their duties. Premium to be paid by Association.

Section 14. The Board of Directors shall examine accounts of the Association at least quarter annually and in addition shall have the books audited by a disinterested accountant at least once a year. The Board may delegate the quarter-annual audit to any three persons specially qualified in the opinion of the Board to make such an audit.

Section 15. The Board of Directors shall not practice Nepotism.

Section 16. Any Director or officer of the Association may, for cause, at any annual or special meeting of the Association be recalled from an office by a majority vote of not less than two-thirds of the members present. Such officer or director shall be notified in writing of the charges preferred against him at least five days before such meeting, and shall have opportunity at such meeting to be heard in person or by counsel and may call witnesses.

ARTICLE VII, Limits of Service

Section 1. The Association shall not deal with or for non-members.

ARTICLE VIII, Fiscal Year

Section 1. The fiscal year shall end on————————of each year.

ARTICLE IX, Enactment, Amendment, and Repeal of By-Laws

Section 1. By-Laws may be enacted, amended or repealed at any meeting of the Association by a vote of a majority of members present, unless otherwise provided by law.

SAMPLE FORM OF AGREEMENT SIGNED BY A MEMBER OF AN ARTIFICIAL BREEDING ASSOCIATION

This agreement made and entered into this......day of........... 19...., by and between the Langlade County Breeders Co-operative, a co-operative association organized under the laws of the State of Wisconsin, party of the first part, hereinafter referred to as the "Association," and....................of............, a livestock breeder, party of the second part, hereinafter referred to as the "Breeder."

WITNESSETH:

1. That the "Breeder" hereby makes application for membership in the Association and if accepted agrees to pay the membership fee of $5.00 required of all members, and agrees to live up to and be bound by the Articles of Incorporation and By-Laws and all other rules and regulations now in force or hereinafter adopted by the Association.

2. That the Breeder agrees to make use of the services of the Association in the breeding of not less than————cows and such other animals as may from time to time be agreed upon and pay therefor the fees prescribed for such services by the Board of Directors of the Association.

3. That the Association will make available to its members the services of healthy bulls of various breeds of dairy cattle of recognized merit and breeding and make available to the Member the services of healthy males of other domestic animals of recognized merit and breeding when there is sufficient demand therefor, as determined by the Board of Directors of the Association.

4. That the Association will make available to its Members the service of a licensed veterinarian of recognized ability, who, under the direction of the Board of Directors shall give the Members the following types of service: (1) Artificial Insemination of female animal; (2) pregnancy examinations; (3) clinical examination of shy breeders in relation to determination of ability of animal to reproduce; and (4) any other service which the Directors will deem necessary. It is agreed that the Association has fulfilled its obligation when the animal is diagnosed as pregnant by the Association Veterinarian. It is further agreed that services of healthy bulls or males, referred to in this contract, is artificial insemination and is construed to mean the deposition of semen into the vagina or cervix of the cow by other than natural methods.

5. That the officers of the Association will keep and make available to the members, when requested, proper records of insemination, semen samples of bulls or other males from which they were taken, pedigree of the sire, health record of the sire, female identification, and such other records as may from time to time be deemed necessary by the Board of Directors of the Association.

6. It is mutually understood and agreed between the parties hereto that the Board of Directors of the Association shall establish the fees to be charged by the Association for inseminating female animals and make available to the Members a copy of such fees when requested. Said fee is not to be in excess of $5.00 during the first year after the

acceptance of this contract. The fee specified will entitle the Members to not more than three inseminations for any one animal; nor will the Association be responsible for services or inseminations to animals removed from the area tributary to the center serviced by this Association.

7. It is further mutually understood and agreed that the Association shall have a lien upon the animal bred for the value of the services rendered by the Association to the member until the same is fully paid, fee to be paid at the time of first service.

8. The Member does hereby for himself, his heirs, representative and assignees release the Association of their liabilities of every kind and nature arising, or which might arise, from any act of commission or omission on the part of any of the agents of the Association, including the Veterinarian.

9. This agreement shall be in effect for the term of three years from and after the date of its acceptance by the Association; it shall continue in effect for successive terms of one year each after the expiration of the original term, subject to the right of either party to terminate this agreement at the expiration of any such term by giving written notice by registered mail to the other party not less than thirty (30) days prior to the expiration of any such term.

10. This contract will take effect and be binding on both parties only after the assignment of .... cows and upon approval of the Board of Directors.

11. This contract covers the request of the undersigned for the services of Registered......................... Sire.

12. The Member hereby certifies that he has........ cows of serviceable age on his farm on the date of the signing of this agreement, of the following breed: ....

13. The parties agree that there are no oral or other conditions, promises, covenants, representations or inducements in addition to or at variance with any of the terms hereof; and this agreement represents the voluntary and clear understanding of both parties fully and completely.

In Witness Whereof, the parties have hereunto set their hands this .... day of ...., 19.....

In the presence of: ....

Breeder

.... LANGLADE COUNTY BREEDERS CO-OPERATIVE

.... By: ....

Sec'y-Treas.

This Contract approved by the Langlade County Breeders Cooperative this .... day of ...., 19.....

President

....

Secretary

SUGGESTIONS FOR WEIGHING PIGS

The best method of weighing pigs at 56 days of age is by using a bathroom scale. A small farm platform scale also works very well.

The weigher should adjust the scale to make his weight even. If the scale cannot be adjusted to an even weight, one may add weights to make an even figure. For example, if the weigher weighs 177 pounds, he may adjust the scale to 180 pounds or add a three-pound weight to his pocket. This will make it a rapid and easy calculation to subtract the man's weight from the combined weight.

If the ages of the pigs of different litters do not vary too much, all may be weighed on the same day and the weights calculated to the 56 day basis. This adjustment is made by multiplying the actual total litter weight by the factor opposite its actual age as listed in the Table. For example, if the litter weighs 300 pounds at 60 days of age, multiply the total actual litter weight of 300 pounds by the factor found opposite the age of 60 days which is:

300 x .91=273 pounds at 56 days.

Individual pigs are weighed the same way; for example, a pig may be found to weigh 44 pounds at 70 days of age. Multiply 44 pounds by the factor .75, which is opposite 70 days and the result is:

44 lbs x .75=33 lbs. adjusted 56-day weight.

Days of age	Factor	Days of age	Factor	Days of age	Factor
40	1.64	51	1.14	62	.87
41	1.58	52	1.11	63	.85
42	1.52	53	1.08	64	.84
43	1.46	54	1.05	65	.82
44	1.41	55	1.02	66	.80
45	1.37	56	1.00	67	.79
46	1.32	57	.98	68	.77
47	1.28	58	.95	69	.76
48	1.24	59	.93	70	.75
49	1.21	60	.91	71	.73
50	1.17	61	.89	72	.72

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